CERC-BEE Task 8-1

Building Labeling Systems and Policies: A Comparative Study of Building Labeling in US and China

Prepared by

The Natural Resources Defense Council (NRDC)

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Note: This paper is a draft which only addresses US systems and policies.

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Foreword

Task 8 of the U.S.-China Clean Energy Research Center's Building Energy Efficiency Project (CERC-BEE) calls for a review and comparison of building energy efficiency (BEE)- related policies in the United States and China. As defined in CERC-BEE's joint research plan between the U.S. and China, Task 8 includes three topics:

- Task 8-1. Comparing U.S. and Chinese building labeling and rating systems;
- Task 8-2. Researching into methodologies for setting building energy consumption quotas and carbon trading schemes; and
- Task 8-3. Examining U.S. and Chinese policies on building energy efficiency (BEE), renewable energy use in buildings and green buildings.

This report summarizes one of two studies issued under the auspices of Task 8-1. The report was prepared by the Natural Resources Defense Council (NRDC) and is focused on U.S. existing rating and labeling systems and related policies. A separate research conducted by the NRDC's Chinese counterpart, the Center of Science and Technology of Construction, Ministry of Housing and Urban-Rural Development (MoHURD/CSTC), focuses on China labeling and rating systems.

This report provides a comprehensive overview of the existing rating systems in the U.S., describes U.S. current use of ratings/ labels, and policies, identifies how ratings and labels can help both the U.S. and China to achieve their goals of reducing energy use and pollution through energy efficiency and sustainability improvements in new and existing buildings. It also analyzes the existing technical and policy gaps and barriers of ratings/labels usage in the U.S., and provides recommendations that will further encourage increased building energy efficiency in new and existing buildings, and facilitate further market adoption of ratings in the US.

Additionally a detailed comparison matrix, as an appendix, was jointly developed by NRDC and MoHURD, containing 34 categories covering background, policy aspect, technical aspect, and real projects. This information-rich matrix greatly facilitated the comparison, analysis and potential alignment of U.S. and Chinese building rating and labeling systems.

The primary authors of this report are MegWaltner and David Goldstein. Xiang Liu, Xin Sherry Hu, Richard Liu and Jingjing Qianhave provided informational and/or editorial input to the matrix and the report.

Abstract

Both the US and China have enormous potentials to reduce energy use and pollution through energy efficiency improvements in new and existing buildings. Despite the fact that these investments in energy efficiency are cost-effective, they are not being undertaken due to a variety of persistent barriers, discussed below. Information about building energy efficiency and energy usage and costs is a key ingredient to the proper valuation of energy efficiency in the marketplace and enables the implementation and enforcement of policies to promote energy efficiency in buildings.

While the US and China face somewhat different challenges in addressing the efficiency of their building stocks, there are also many similarities and potential to learn from each other. Both countries have made significant progress on the development of labeling and rating systems for buildings, but there is still much progress to be made. In 2009, the Natural Resources Defense Council, the Chinese Ministry of Housing and Urban-rural Development, and the Institute for Market Transformation published the first comparative report on China and US labeling and rating systems.[1]

This paper builds upon and updates this work. It will give an overview of existing rating systems in the US and China; describe what information they rely on, how they are determined, and how they are being used today, including an overview of existing policy mechanisms. It will identify how ratings and labels can be used to help achieve goals for increasing both efficiency and sustainability of buildings in US and China, identify what the gaps and barriers are for the use of labels in each country, what each country can learn from the other to patch these gaps, and identify opportunities to work together to solve mutual challenges.

[1]Mo et al, 2010, Comparative Analysis of US and China Building Energy Rating Systems, ACEEE Summer Study Proceedings.

Introduction

How Labels and Ratings Can Enable the Transformation of Markets for Efficient Buildings

There is an immense potential both in the United States and China to reduce energy use in buildings with extremely attractive rates of return. For example, the U.S. National Academy of Sciences' study America's Energy Future finds a potential savings in buildings of almost $170 billion a year in 2030 for a cumulative investment cost of $440 billion, which amounts to a rate of return on efficiency investment of more than 30 percent.[2] Why is it possible for such opportunities to remain in a market economy for so long, in an era when rates of return on market investments are below 5 percent?

The explanation is that a broad and deep array of market failures prevents the introduction of efficiency technologies and design approaches. They impede not only the roughly 30 percent savings identified from existing off-the-shelf technologies in the National Academy of Sciences' study and in other comparable studies, but also discourage the commercialization of the next generation technologies that *would be* introduced by their manufacturers and designers if only their existing technologies were profitable enough to make the distinction of next-generation efficiency worth something in the marketplace.

To address these failures of market requires a broad array of market interventions across the entire range of market adoption levels illustrated in Figure 1.

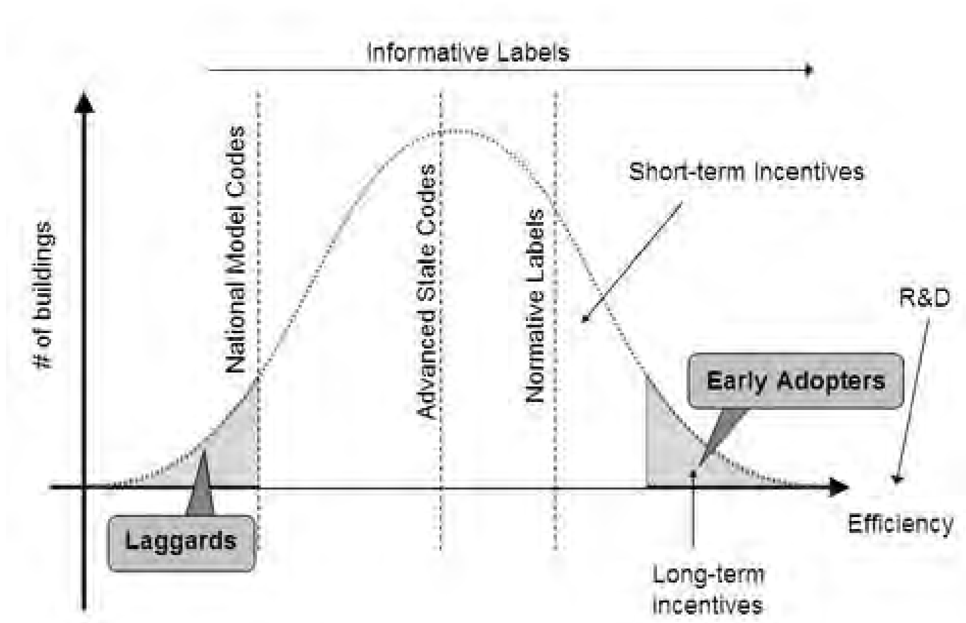

Figure 1: Necessary Market Interventions at All Stages to Transform Markets for Building Energy Efficiency

[2]NationalAcademy of Sciences, National Academy of Engineering, and National Research Council. 2010. *Overview and Summary of America's Energy Future: Technology and Transformation*, Washington, DC: The National Academies Press

These interventions are:

- *Minimum codes and standards*. At the broadest level of acceptance, and the smallest level of technological ambition, energy codes, which can affect virtually 100 percent of all new construction and ensure a minimum level of energy efficiency.
- *Normative labels*. At the next higher level of technology (and the next lower level of market penetration), simple normative labels, such as the ENERGY STAR label in the United States or the Star system in China can help encourage market adoption of more efficient technology. A normative label distinguishes an efficient product but does not necessarily provide detailed information about that product's efficiency. Specifically, a normative label does not allow for comparison to the efficiency of other products or reference points. For example, a normative label does not give information on two buildings comparative efficiencies (what percentage more efficient is one than the other) or provide modeled energy use under standard operating conditions, but does distinguish more efficient buildings or products from a pool of less efficient products.
- *Informative labels* provide more details about the efficiency of a building or product and allow the consumer to compare the efficiencies of multiple products and evaluate information on energy use or costs. This will be elaborated on below.
- *Short-term, Managed incentives*. These are incentives offered by an administering agency, such as a utility or a state, provincial, or national government, that has a budget to promote energy efficiency options. The management aspects of these incentives are: 1) that they have to be for technologies simple and available enough that the customer will not be disappointed to find an incentive for something that he or she cannot actually install or purchase; and 2) adjusted as necessary to maintain a specific budget (efficiency criteria can be adjusted if initially set too stringent or too weak).
- *Long-term incentives* (3-5 year incentives). These incentives are provided to address the far right tail of the figure – to provide the incentives to introduce *brand new* technologies and designs, or ones that currently capture an utterly insignificant share of the market, by making it profitable for producers to invest in new products and production facilities or architects or engineers to invest in serious professional development to be able to produce these designs.
- *Market-directed research and development*. Research and development leads to the next generation of efficient technologies and enables the continued shift of this curve to the right.

Building labeling and rating programs are intimately connected with all phases of these market interventions, in addition to being a form of policy intervention in and on their own.

This is how a building and ratings system can assist at all levels of the spectrum:

- *Building codes*. Building codes typically offer two paths for compliance: a prescriptive path and a performance-based path. In most jurisdictions, the performance-based path is nearly unusable because it requires the complying designer both to simulate the performance of his or her building, which is expensive and time-consuming, and most often to simulate the performance of a building that meets the prescriptive standard. In addition it requires the designer to convince the code official that the simulations have been done properly and that the official can understand the outcome of the simulation program in a way sufficiently assures him or her that the code has been met. Because of these barriers, performance-based compliance is used only in a trivial number of buildings in the US, except in jurisdictions such as California and Florida where performance-based compliance has been automated.
  This automation is also integrated into the process for rating and labeling buildings, so the labeling/rating system provides complementary support to the building codes. How this works is

that the predicted energy consumption in the labeling and rating procedure is used as a comparison with the levels required in the code.

This complementariness helps increase the stringency of energy codes over the years. The politics of energy codes frequently pits advocates of new efficiency technologies against builders or building owners who have concerns about the cost, availability, or performance of the new technologies. If most builders comply using a performance basis, the effect of any particular technology is much less important because it isn't actually required – there are tradeoffs methods available to avoid using it.

- *Normative Labels*. Normative labels typically are based on achieving a given level of performance. In most cases, this level of performance is a numerical target on the labeling and rating scale. For example, the US ENERGY STAR system for new homes uses the HERS scale for its performance pathway, described in detail in Section 4.a.ii.1.

- *Informative labels*. If the goal is to make markets work, informative labels are an essential ingredient in making that happen. *Markets only work when there is perfect competition in the trade of a known good.* And a building whose energy performance cannot be evaluated quantitatively compared to other buildings is not a known good. All of the policies listed in these bullet lists are designed to simulate the effects of a perfectly competitive market. Thus, a rating and labeling system that provides information on projected energy use and costs underlies everything in the entire list.
- *Managed incentives*. Managed incentives have worked effectively in the United States when they are based on target that is keyed to the labeling and rating system. For example, many utilities have created programs that achieve a given percentage savings compared to an energy code.
- *Long-term incentives*. Long-term incentives should have stringent, but achievable criteria and a long enough time period for the industry to meet these criteria. Perhaps the best example of the importance of labeling and rating systems is in the two long-term incentives adopted by the U.S. Congress in the Energy Policy Act of 2005 (EPAct 2005), which are described in detail in Sections 5.a.i and 5.a.ii. One of these incentives, the Section 45L new homes credit achieved significant market penetration, despite demanding levels of performance largely due to ease of verification using the HERS rating system.

  The other, Section 179D provides an incentive for 50 percent reductions in energy use for commercial buildings, but in this case, no methodology was available for doing this calculation: there was no nationally-recognized labeling and rating system for nonresidential buildings. As a consequence, many large and sophisticated commercial building owners found that merely *demonstrating* compliance exceeded the value of the incentive. In response to this need, non-profit organizations created the Commercial Energy Services Network (COMNET) labeling and rating system.[3] It will be interesting to observe, once COMNET-compliant software becomes available, probably in the first quarter of 2012, whether the uptake of this incentive is increased.

  But the fact that there was very little uptake of the commercial buildings incentive, despite the perception that the savings were easier to achieve in commercial buildings than residential, points to the fundamental importance of a labeling and rating system.

In addition to these criteria, *labeling and rating systems allow energy costs to be considered in the financing of buildings.*

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[3] For more information see http://www.comnet.org/

In the United States, home ownership is encouraged by the institution of 30-year loans that cover up to 80 percent of the value of the property (up to a 100 percent during the real estate bubble). A prospective borrower's fitness to repay the loan is judged by a comparison of the monthly payments to the borrower's income as well as considering other factors such as credit score. Variation in energy costs are not considered in this equation, so a more energy efficient home with a higher first cost is considered *less affordable* when evaluated by an underwriter than a less efficient home with a lower first cost, *even when the monthly payments for the incremental costs of efficiency are substantially lower than the monthly savings in utility bills.* Rectifying this problem would probably have reduced the severity of the global credit crunch of 2007-8, based on an analysis of the very strong statistical correlation between poor location efficiency of homes and high default probabilities, as will be discussed in Section 3.a.i below.

A parallel situation occurs in commercial buildings. Many commercial buildings are appraised based on the "net operating income" method, in which the expected revenue in rentals is compared to the expected operating costs, including energy. The resulting net income is multiplied by a "capitalization rate" which is currently around 20 years at present interest rate, to calculate an appraised value. The size of the loan on the commercial building depends on the appraised value, as a percentage. In part due to the lack of a recognized labeling and rating system for commercial buildings, the energy cost estimate is usually filled out using a metropolitan area average rather than a building-specific number. A nationally recognized labeling and rating system would allow real numbers to be used, providing greater market value for energy efficiency in the loan process.

Policy Context

Building energy labels and rating systems are an essential ingredient for successful policies to promote building energy efficiency. Because ratings and labels act as tool, a means to an end, it is important to understand the context in which they operate. What are the problems that are trying to be addressed? What is the state of efficiency in the existing building stock? What programs, policies, or other tools or mechanisms currently exist to increase this efficiency? What is the rate of new construction? What regulations exist to ensure energy efficiency in new construction and how are these enforced? How are buildings financed and operated? This section will address these and other questions to describe the system under which ratings and labels operate in both the US and China.

Overview – Current Situation, Challenges and Goals

Residential and commercial buildings account for approximately 40 percent of annual energy consumption in the US, as shown in Figure 2. Energy use in buildings is fairly evenly split between residential (22 percent) and commercial buildings (18 percent). In the US, the residential market is comprised mostly of single family homes (63 percent of homes in the US are detached, 6 percent attached single family, 8 percent multifamily with less than 4 units, 17 percent multifamily with 5 or more units, and 6 percent mobile homes).[4] Recent data and market studies suggest that an increasing share of new residential construction will be multifamily[5]. All other buildings are generally lumped into the category of commercial buildings, which generally includes everything from standard office buildings, to retail malls,

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[4]US Energy Information Administration, 2009 Residential Energy Consumption Survey, http://205.254.135.7/consumption/residential/data/2009/

[5] Nelson, Arthur, 2011, How Demographics and Economic Trends May Shape the Housing Market: A Land Use Scenario for 2020 and 2035, Urban Land Institute.

to warehouses, to datacenters, etc. High-rise multi-family buildings sometimes fall into the commercial building classification, or as its own category.

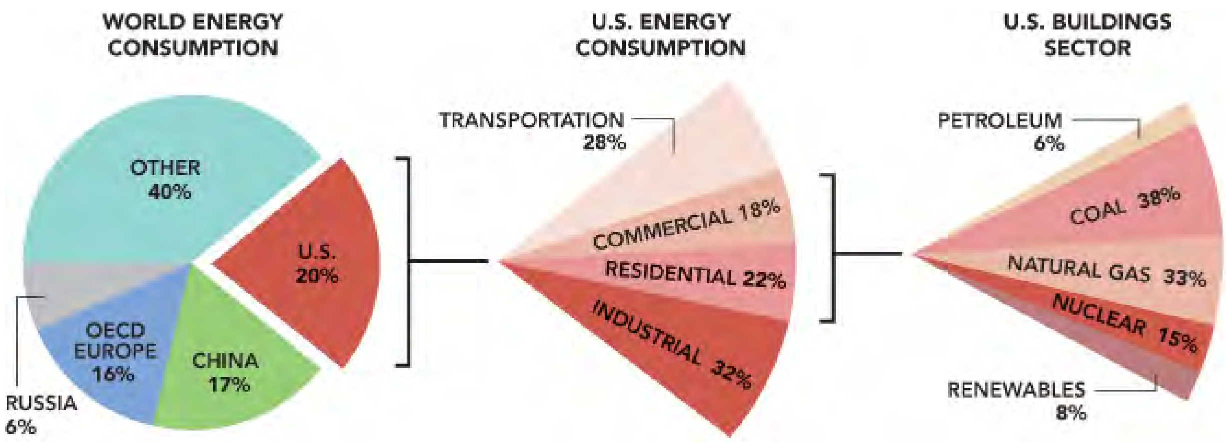

Figure 2: Energy Consumption in the US Buildings Sector.[6]

United States

The current situation with respect to energy efficiency in buildings in the United States comes in the wake of the real estate meltdown of the last several years. Construction of new houses is approximately one fourth what it had been 5 years ago, and activity in the commercial sector is similarly distressed.[78] As will be discussed, these trends are unlikely to be reversed in the near term (5 years or less). Thus, the primary challenge in the near future in terms of reducing the energy used by buildings will be in retrofitting the 113 million homes and 4.9 million commercial buildings already in existence in the US.[9] It is therefore critical for policies to address retrofits and to have labeling and rating systems that can be used for retrofits

As background, here is why it is unlikely that either new construction market will revive in the near future: The lending processes for both residential and commercial buildings have never paid any attention to energy efficiency. But, energy efficiency in the United States means far more than the energy consumption of the buildings themselves. The typical utility bills for a residential building, taken over the life of the 30-year loan, are about $75,000 but the cost of transportation to and from the home, if it is located in suburban sprawl, are approximately $350,000 and the overwhelming bulk of new construction over the last two decades or so has been in suburban sprawl. (This observation probably explains why the amount of personal travel in automobiles continued growing after 1973 at approximately the same rate as

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[6] US Department of Energy, Building Energy Data Book, http://buildingsdatabook.eren.doe.gov/ChapterIntro1.aspx, Accessed 5/24/12

[7]US Energy Information Administration, 2009 Residential Energy Consumption Survey, http://205.254.135.7/consumption/residential/data/2009/, Accessed 5/24/12

[8] US Department of Energy, Building Energy Data Book, 1.3.2 Value of Construction and Research, http://buildingsdatabook.eren.doe.gov/docs/xls_pdf/1.3.2.pdf, Accessed 5/24/12

[9] US Energy Information Administration, 2003 Commercial Buildings Energy Consumption Survey, http://www.eia.gov/emeu/cbecs/cbecs2003/overview3.html, Accessed 5/24/12

it had before that time, subsequent despite stagnation in median income per household and a lack of price reductions in anything associated with the automotive system, coupled with a highway construction rate low enough that the number of kilometers of highways grew more slowly than the number of cars trying to use them.)

There is a strong case to be made that one of the contributors to the mortgage default crisis in the U.S., which had credit repercussions throughout the world, was the failure to include location efficiency in lending origination. Location efficiency is so important because the cost of fuel that is saved by more location efficient development is less than one-fifth of the total cost of driving automobiles. Increased location efficiency takes the form of much greater reductions in car ownership than in kilometers traveled per car, so the economic impacts of poor location efficiency (or, the economic benefits of high location efficiency) account for large cost savings in owning and insuring and parking cars. A recent study of defaults and location efficiency found that when location efficiency was added to a vector of potentially explanatory variables predicting mortgage defaults, the location efficiency term was usually statistically significant at the 99 percent confidence level.[10]

Presently, the market for suburban sprawl housing is burdened by large numbers of distressed properties that have defaulted on their mortgage, and other neighboring properties whose values are so low that the outstanding loan amount exceeds the net value of the home. Clearly there is not much motivation to build new homes in these areas in the next several years. To the extent that such building is going on, it is thus not surprising that such a large number of builders have agreed to put energy ratings on their homes; to compete against nearby distressed properties selling at a discount, it helps to have documentation that the $75,000 in typical utility bills might be only half, for example, for a home with an energy rating.

But, the long-term challenge facing the U.S. economy with respect to new housing construction is that the demographic that has preferred suburban sprawl housing – two-parent families with school-age children – is not predicted to grow substantially over the next 20 years. The nation already has more sprawl housing than the 2035 demographic would suggest is needed.[11] Instead, where there is a deficit of housing compared to the projected demographics is in more location efficient areas where housing prices are higher. Until lending is reformed to allow higher-priced homes to be “affordable” (as defined by the lender) to families with the same income, it is unlikely that the housing market will revive.

Somewhat parallel problems afflict the commercial sector. A recent study found that the amount of driving associated with employees and customers coming to the site of a commercial building significantly exceed the energy used by the building itself.[12]Again, it is likely that this amount of driving differs between commercial buildings located in sprawl compared to buildings with higher density and more transit-accessible locations, although major research supporting or refuting this expectation is lacking. At any rate, it is hard to find credible analyses suggesting recovery in the new construction markets in the foreseeable future.

Serious retrofits for new homes—that is, construction projects whose motivation is to save energy, as opposed to repair projects such as window replacement that produce some efficiency gains as a side effect—are very uncommon.

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[10] Rauterkus, S. et al, 2010 Location Efficiency and Mortgage Default, JOSRE Vol. 2, No. 1

[11] Nelson, Arthur, 2011, How Demographics and Economic Trends May Shape the Housing Market: A Land Use Scenario for 2020 and 2035, Urban Land Institute.

[12] Wilson, Alex and Rachel Navaro, Driving to Green Buildings: The Transportation Energy Intensity of Buildings, Environmental Building News, http://www.buildinggreen.com/auth/article.cfm/2007/8/30/Driving-to-Green-Buildings-The-Transportation-Energy-Intensity-of-Buildings/, Accessed 5/24/12

Widespread market uptake of retrofits would seem to require a combination of three factors in order to get established:

- A widely-available and utilized home energy rating system that provides estimates of savings from potential retrofit energy efficiency measures as well as estimates of their likely cost, as well as referrals to reliable contractors and sources of financing.
- An easy-to-use and trustworthy way for consumers to identify contractors who can do a good job of home retrofitting at reasonable prices, with supporting training and certification programs to make sure that this industry understands the building science issues they're dealing with; and
- A simple way to finance cost-effective energy improvements. At present, to the extent that there is financing available for retrofits at all (some 20 percent or more of US homes have mortgage balances that exceed the appraised value of the home, and are ineligible for any sort of financing), the interest rates are based on non-credit worthy borrowers, and may exceed 10 percent per annum, in contrast to the rates of approximately 4 percent as of July-November 2011 that credit-worthy borrowers can obtain.
  Since the evidence suggests that the security of a first mortgage is enhanced if total monthly costs (retrofit loan repayment plus monthly utility bills) are lower, it would make sense for the owner of the first mortgage to encourage further credit availability just to protect the initial investment in the mortgage, if not to make additional profit on the origination and servicing of the retrofit loan. But, this is not how the lending industry has seen it at present.

As of the end of 2012, Residential Energy Services Network (RESNET) has a widely available home energy rating system, but not many home dwellers are aware of it, or even understand the concept of energy efficiency.[13] RESNET and the Building Performance Institute (BPI) also have contractor certification programs, but neither is populated by a large and regionally inclusive set of contractors, and neither system is well known to the public.

Various structures have been proposed at Congress and at the utility and state program administrative level for developing retrofit incentives in order to kick-start the market and to provide all three of these services at once. These include proposed retrofit programs in the American Clean Energy and Security Act[14] and the Home Star legislation[15], both passed by the US House of Representatives in 2009 and 2010, respectively and the Cut Energy Bills at Home Act recently introduced in the US Senate by Senators Snowe, Bingaman, and Feinstein.[16]

For commercial buildings, the leading property managers believe that they can get some 30 percent energy savings through retrofit investments that pay back in 3 years or less and savings of 10 percent or more based on simple cost-free improvements in building operation. Recently, we have found evidence of deep retrofits that can reduce the energy consumption of buildings by 50 percent compared to the US national average.[17] The data supporting this are rather sparse but consistent. So the retrofit challenge is to try to encourage broader and deeper retrofits in the commercial building sector. This could work in a synergistic way with the fast growing market for certified green buildings.

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[13] Attari, Shahzeen et al, 2010, Public Perceptions of Energy Consumption and Savings, Proceedings of the National Academy of Sciences, Early Edition
[14] US House of Representatives, 111th Congress, H.R. 2454, American Clean Energy and Security Act of 2009
[15] US House of Representatives, 111th Congress, H.R. 5019, Home Star Energy Retrofit Act of 2010
[16] US Senate, 112th Congress, S. 1914, Cut Energy Bills at Home Act
[17] New Buildings Institute, 2011, A Search for Deep Energy Savings in Existing Buildings

Initial evidence points to the ability to obtain higher leasing percentages as well as higher lease rates per unit floor area if buildings are green. For example, a 2008 Study by CoStar Group found that LEED buildings garnered rents that were $122 more per square meter and had a 4.1 percent higher occupancy rate. ENERGY STAR rated buildings garnered $25.80 additional rent per square meter with a 3.6 percent higher occupancy rate. The same study found that ENERGY STAR and LEED buildings also sold for an average of $656 per square meter and $1840 per square meter more than equivalent buildings, respectively.[18]
Such a trend could start to promote retrofits in a market in which new construction is depressed. The concern would be that a green reputation could be obtained by a building owner with minimal improvements in energy efficiency.

Policy mechanisms proposed to jumpstart this market and push it towards higher levels of savings include the Retrofit for Energy and Environmental Performance (REEP) program in the Waxman/Markey bill and proposed modifications to the existing commercial building tax deduction (26 USC 179D).

The term jumpstart is used because for both residential and commercial retrofits, it would seem that once retrofits become a significant factor in the market, the barriers to them will be overcome by the ease of initiation of projects that will have been brought about by the market response to the incentives.

Current Policies

United States

This section describes current mechanisms and structures that encourage building efficiency in the United States. They are structured similarly to the discussion in Section 2.a.:

- *Building energy codes and appliance efficiency standards*. Energy codes are enforced primarily at the county and municipal level. Occasionally, such local agencies set their own codes; this is happening more frequently in recent years as cities become more sensitive to issues of climate change mitigation and green buildings. But most codes are adopted at the state level. States can, in principle, choose whatever structure of codes they desire, but the vast majority of state codes rely on national models, primarily the International Conservation Code (IECC) for all buildings but with an emphasis on residential, and the American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE) Standard 90.1 standard for non-residential buildings.

  These model codes are developed using a very complex process organized by their drafting agencies, respectively, the International Codes Council (ICC) and ASHRAE. Both are non-profit organizations who develop standards following their own internal voting procedures. Standards are determined by a purely political process in that neither organization establishes objective criteria to which codes must be developed. (Examples of such objective criteria include the U.S. appliance efficiency standards law that require standards be set at the maximum level of efficiency that is technologically feasible and economically justified, or numerous policies prescriptions that standards be set in a way that minimizes the present value of efficiency measures and energy costs over the building lifetime.) At the ICC, the process is a majority vote of code and related government officials present at code development hearings. At ASHRAE the process is an American National Standards Institute (ANSI) consensus process, which requires that the committee that sets the standard be balanced between

[18] Miller, Norm et al. 2008. "Does Green Pay Off?" http://www.costar.com/uploadedFiles/JOSRE/pdfs/CoStar-JOSRE-Green-Study.pdf.

"producers", "users", and "general interest" members, and that it decide by "consensus" meaning more than a simple majority but less than unanimity.

Thus, as energy becomes important to these non-profits, increases in stringency are more likely, whereas when interest in energy wanes, the standards have tended to stagnate. Stakeholder interests are also very important in the level of standards, with a recent trend for more political influence by efficiency suppliers and advocates than by home builders, who in the past have opposed increases in energy code stringency. For example, in 2009 the American Clean Energy and Security Act[19] which passed the House but was not voted on in the Senate included 30 percent improvement targets for the model energy codes with a backstop of DOE designed codes in the case the nonprofit organizations could not meet these targets. Despite the fact that this legislation did not end up becoming law, it chance of passage was serious enough that ICC and ASHRAE both adopted the 30 percent targets and met them in their most recent editions of the codes.

While the model codes are generally updated every three years, states and localities must adopt them to have any effect. Because of the mix of jurisdictional levels between development, adoption, and implementation of code, adoption and implementation often lags. Adoption is often slow due to lengthy state adoption processes, political opposition from builders and other opponents, lack of knowledge or resources, among other reasons. Adoption varies widely from state to state, as shown in the BCAP code maps.[20] Close to a dozen states have no or very outdated codes, while many have adopted the most up to date codes and the rest falling somewhere in between.

Even in states that have adopted the most recent building energy codes, enforcement is highly variable. Some of the reasons that have been identified include: lack of familiarity by the local enforcement officials (who enforce all types of building codes) with the technical requirements of the energy code; lack of priority assigned to something that does not directly affect life safety, as a fire code or an electrical code would; lack of understanding of the code by builders and their design professionals who would have to comply with them, and an ability in practice to bypass an additional bureaucratic step that bears some modest amount of cost, when such a bypass can be done.

Also, it is frequently claimed that municipalities lack the financial resources to do a good job of energy code implementation. A recent analysis by IMT suggested an $810 million funding gap in the US in order to achieve 90 percent energy code compliance.[21] Some states and municipalities have put more resources into code implementation and have relatively good records. Most jurisdictions have little hard data on how well energy codes are implemented, leading to widespread anecdotal experience that codes are unenforced or poorly enforced without quantitative evidence of how badly the energy targets that would be achieved by full compliance are missed.

Commercial buildings are often designed by firms that operate across state and national boundaries. Thus, compliance with the standard such as ASHRAE 90.1 often occurs due to simple customary design practices even when the design is being developed for a jurisdiction that does not effectively enforce the code.

In addition to building energy codes, the efficiency of appliances and equipment in the US is regulated by the Department of Energy under the National Appliance Energy Conservation Act as

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[19] US House of Representatives, 111th Congress, H.R. 2454, American Clean Energy and Security Act of 2009
[20] For code adoption status maps, see: http://bcap-ocean.org/code-status
[21] Institute for Market Transformation, "$810 Million Funding Needed to Achieve 90% Compliance with Building Energy Codes," http://www.imt.org/files/FactSheet-EnergyCodeComplianceFunding.pdf, Accessed 5/24/12

amended by subsequent legislation. DOE sets minimum efficiency standards for 55 types of residential and commercial appliances and equipment. These include residential and commercial HVAC equipment, residential appliances (dishwashers, refrigerators, clothes washers, etc), lighting and other equipment. As mentioned above, DOE is required to set these standards at the maximum levels which are "technologically feasible and economically justified" and to update these standards every six years. While these regulations do not directly apply to buildings, they significantly affect the energy used by buildings and have been one of the most successful policy tools for encouraging continued improvement and implementation of energy efficiency over the last few decades.

- *Normative labels*. In the United States, the normative label for new homes is ENERGY STAR which has been roughly based on a percentage savings from the IECC code. Both prescriptive and performance paths for demonstrating compliance are offered, as described in Section 4.a.i.1.
The normative rating system for commercial buildings is also ENERGY STAR, but this is a different program design than almost any of the other ENERGY STAR programs in that it is based on energy intensity from metered usage in an already occupied building. ENERGY STAR awards its recognition label to the top 25 percentile of buildings, per the methodology described in Section 4.a. i.2.

This program clearly encourages retrofits and improvements in energy management. But since the program is focused on existing buildings, it is not clear how much it has affected new construction. ENERGY STAR has a program focused on new construction using a procedure called "Target Finder" to connect the design of the building with its expected energy performance. But, as elaborated below, the program does not contain any actionable design recommendations or even specific calculations procedures that would connect the design of a proposed building that was to be newly constructed and the resulting energy consumption.

- *Informative labeling*. The ENERGY STAR for new homes program has grown to a market share of an average of 25 percent in 2010 by offering recognition for a fixed level of efficiency beyond code, a level that is adjusted upwards every few years.[22] A significant percentage of ENERGY STAR homes are built without any financial incentives other than pure recognition. In addition, in the past year, a large number of builders have signed memoranda of understanding with RESNET to provide HERS ratings on all their new homes. This change might be seen as a response to the need to distinguish oneself in the marketplace from lower-cost foreclosed-upon properties.
There is not currently an implemented system for labeling and rating U.S. commercial buildings based on their design. This will be discussed further in Section 4.a.i.2.

- *Managed incentives*: Managed incentives are typically administered at the utility, local, regional, or state level, as these entities have the ability to oversee such programs. A comprehensive resource for information on energy efficiency and renewable energy incentives in the US is the Database for State Incentives for Renewables and Efficiency website.[23] For example California has had a broadly-available and relatively successful program for new homes for many years, which offers builders with an incentive for building ENERGY STAR home or homes that meet more stringent efficient criteria.[24] California also has a program for new and major retrofits commercial buildings called Savings by Design which offers building owners or designers incentives up to $500,000 for

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[22] EPA ENERGY STAR, "2010 ENERGY STAR Qualified New Homes Market Indices for States," http://www.energystar.gov/index.cfm?fuseaction=qhmi.showHomesMarketIndex, Accessed 5/24/12
[23] Database of State Incentives for Renewables & Efficiency, http://www.dsireusa.org/, Accessed 5/24/12
[24] California Advanced Homes, http://www.californiaadvancedhomes.com/about-cahp, Accessed 5/24/12

improving their building's energy efficiency by a minimum of 10 percent on a whole building basis compare to California's energy code.[25]
Utilities throughout the country as well as state energy agencies have large and well-established programs to encourage *retrofits of commercial buildings*. These have been amongst the most cost-effective and most successful managed incentive programs in the United States. However, these programs have been focused on individual "widgets" rather than whole building, or even whole system performance. Many of the incentives encourage action such as the substitution of T-8 lamps and electronic ballasts for the old-fashioned and now too inefficient to qualify for regulation magnetic ballasts and conventional T12 lamps. Other programs focus on replacing rooftop air conditioners with units that have higher ratings. There have been only a few programs that encourage lighting efficiency based on reducing installed lighting power density below targets established by codes or other procedures.

- *Long-term incentives*. We noted above the success of the United States' one-time attempt at implementing long-term incentives for residential and commercial buildings. It should be noted that, for both programs, although the original program design as passed by the chambers of the U.S. Congress called for a four-year program, the final adopted law contained only a two-year program. This was subsequently extended, on the residential side twice for 2 an additional two years each time and on the commercial side for one and than five years. This would be expected to have reduced the effectiveness of the residential program because builders could not make advanced plans to create efficient products relying on the certain availability of the incentive. But the data do not suggest that this failure caused a dramatic difference in the success of the program. It would be expected to undercut the commercial tax incentive completely due to the lead time between the early stages of design, where the most cost effective approaches to saving 50percent or more could be explored, until the asset was "placed in service": this lead time typically is longer than the 2-year span of the EPACT incentive.

Existing Rating and Labeling Programs

There are many types of rating systems that assess and provide information on how energy efficient or "green" a building is. It can often be difficult to capture all relevant information about a building's energy use and sustainability in one system while also translating that information into something that is understandable by the average consumer who does not have an in depth knowledge of building energy use. Therefore, the ideal rating and labeling system may depend on the specific problem to be addressed and in some cases multiple systems in conjunction can be the ideal solution. For rating systems that look at energy use specifically, there are two general classifications: asset ratings and operational ratings. Operational ratings are based on measured energy performance, such as through actual utility bills. An example of an operational rating system is ENERGY STAR Portfolio Manage, described below. Conversely, an asset rating measures the energy efficiency "asset" of the building and allows consumers to make an apples to apples comparison between the efficiency of two buildings, regardless of how they are currently being operated. Current asset rating systems assess a building under standard operating conditions, described in more detail below. A second type of asset rating could be envisioned that would assess the building under actual operating conditions, which would allow a building owner to identify operations and maintenance issues when compared to an operational rating, however no such systems, or at least no such nonproprietary systems, currently exist in the US.

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[25] Savings By Design, http://www.savingsbydesign.com/faqs, Accessed 5/24/12

In addition to systems that address energy efficiency of the building alone, there are also systems that attempt to account for all aspects of a building's sustainability, such as the Leadership for Energy and Environmental Design (LEED) system. These systems incorporate energy efficiency as well as other aspects of sustainability such as indoor air quality, location efficiency, materials, water efficiency, etc. This section provides a comprehensive overview of the existing rating and labeling systems in the US and China.

Energy Efficiency Rating and Labeling Systems

Energy Efficiency Rating and Labeling Systems in the US

Rating systems in the US are generally divided into residential (single family homes and small multifamily) and commercial, which, as described previously, covers all non-residential building types and also high-rise multifamily buildings.

1. Residential Rating Systems

Background. The first Federal effort in the US to increase the efficiency of existing single family homes was in the National Energy Conservation Policy Act of 1978 which did provided grants to states to implement audit and retrofit programs. At that point, energy auditing was a newly developing profession and different practitioners looked at different issues. Over the years, primarily under the leadership of state energy agencies and utilities, auditing methods and building science analytic methods became more sophisticated. Important diagnostic procedures such as blower door testing and duct pressurization testing were developed and deployed.

The importance of incorporating energy efficiency into loan qualification criterion, which was recognized from the early 1980's, led to the observation that national uniformity on how ratings were done would be necessary to get banks, and investors to whom the banks sold mortgages, to participate in such lending programs. The evolving realization that national standards were needed for home energy ratings led to a requirement in the Energy Policy Act of 1992 to develop a voluntary national model for uniform home energy ratings.

DOE worked on this issue for several years, but never issued a final rule. State energy offices, increasingly impatient at the lack of a national voluntary standard, worked through the National Association of State Energy Officials to create a network of state agencies that could agree on, publish and maintain such a national standard. The effort was successful and was spun off as a free-standing non-profit organization called the Residential Energy Services Network (RESNET) in 1995.

Since the development of the initial RESNET standard, other systems have been developed for rating and labeling single family homes. To our knowledge, the HERS system is the only rating system in significant usage in the United States. Other systems that have been developed include the ENERGY STAR label (which uses the RESNET system for compliance), Home Energy Yardstick (a basic operational rating tool), the Earth Advantage Institute Energy Performance Score, and most recently the DOE Home Energy Score. This section will describe all of these rating and labeling systems for single family homes.

RESNET and the HERS Rating System.RESNET adopted the first National Home Energy Rating Standards in 2002 and they have been updated almost every year since.[26] The RESNET standards cover

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[26] RESNET, Mortgage Industry National Home Energy Rating Standards, http://www.resnet.us/standards/mortgage, Accessed 5/24/12

all aspects of an energy rating, not only the technical aspects of an energy audit – what to inspect, what default assumptions for physical conditions whose exact state cannot be determined by inspection, how to calculate estimated energy consumption in a repeatable way, acceptable rating software, and other technical issues; the RESNET standard also covered quality control/quality assurance through establishing certification schemes for raters and continuing requirements for professional educational development and regular testing, as well as establishing ethics criteria and enforcement mechanisms. The RESNET National Home Energy Rating System Standards can be found at: http://www.resnet.us/standards/RESNET_Mortgage_Industry_National_HERS_Standards.pdf. While the RESNET standard was originally developed with the existing homes market in mind, the use of ratings became established in the marketplace primarily through coordination with new home construction programs, including the ENERGY STAR program and programs operated by utilities and energy offices, which is discussed in more detail in Section 5.a.i. As of 2011, over 1 million U.S. homes have been rated according to the RESNET Home Energy Rating System.[27] RESNET is an asset rating system, meaning that, similar to most other efficiency ratings, such as miles per gallon or liters per 100 kilometers for cars, COP for air conditioners, annual kWh of energy consumption for refrigerators, is based on a combination of physical measurements and tests along with engineering simulations. The resulting rating is the Home Energy Rating System or "HERS" rating.

One important aspect of the HERS rating is to assure repeatability by different raters. The RESNET standard requires as quality control/quality assurance that at least 1 percent of each rater's production gets re-rated by a different rater. The quality test is agreement within 3 HERS points, about 3 percent. Repeatability is a more important problem to solve for buildings than it is for equipment, since equipment is mass produced and testing a random but small sample of product coming off an assembly line is easier than testing what may be individually custom-built homes using *in-situ* testing rather than factory testing. But, like the equipment rating systems, the goal of an asset rating is to answer questions about the energy efficiency of a piece of equipment – in this case a building – without reference to the individual behavior of its occupants. Comparing homes on an equal basis is a very expensive research project if the comparisons are based on metered energy consumption, but can be done at very moderate cost if the ratings are based on a limited number of measurements and standardized assumptions about operation.

The HERS rating contains several types of information. The most prominent is the "HERS index," a rating on a scale from zero to 100 and beyond, where 100 represents the IECC 2004 Model Code and zero represents a zero energy home, shown in Figure 3 below. A typical existing home is commonly believed to have a rating of about 130, although there is no data to support this (or any other) estimate as a statistically valid sample of existing homes has not been rated. The HERS rating is independent of house size in the sense that a large home that meets the IECC reference code will score 100, just as a very small home that meets the same code will.

[27] RESNET, http://www.resnet.us/ratings/HERS_Index_Brochure-8-31-11.pdf, Accessed 5/24/12

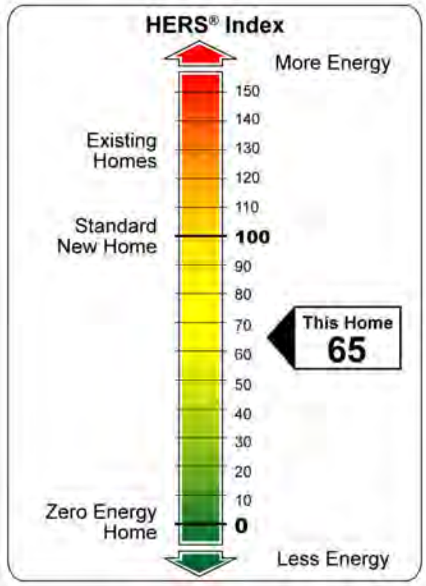
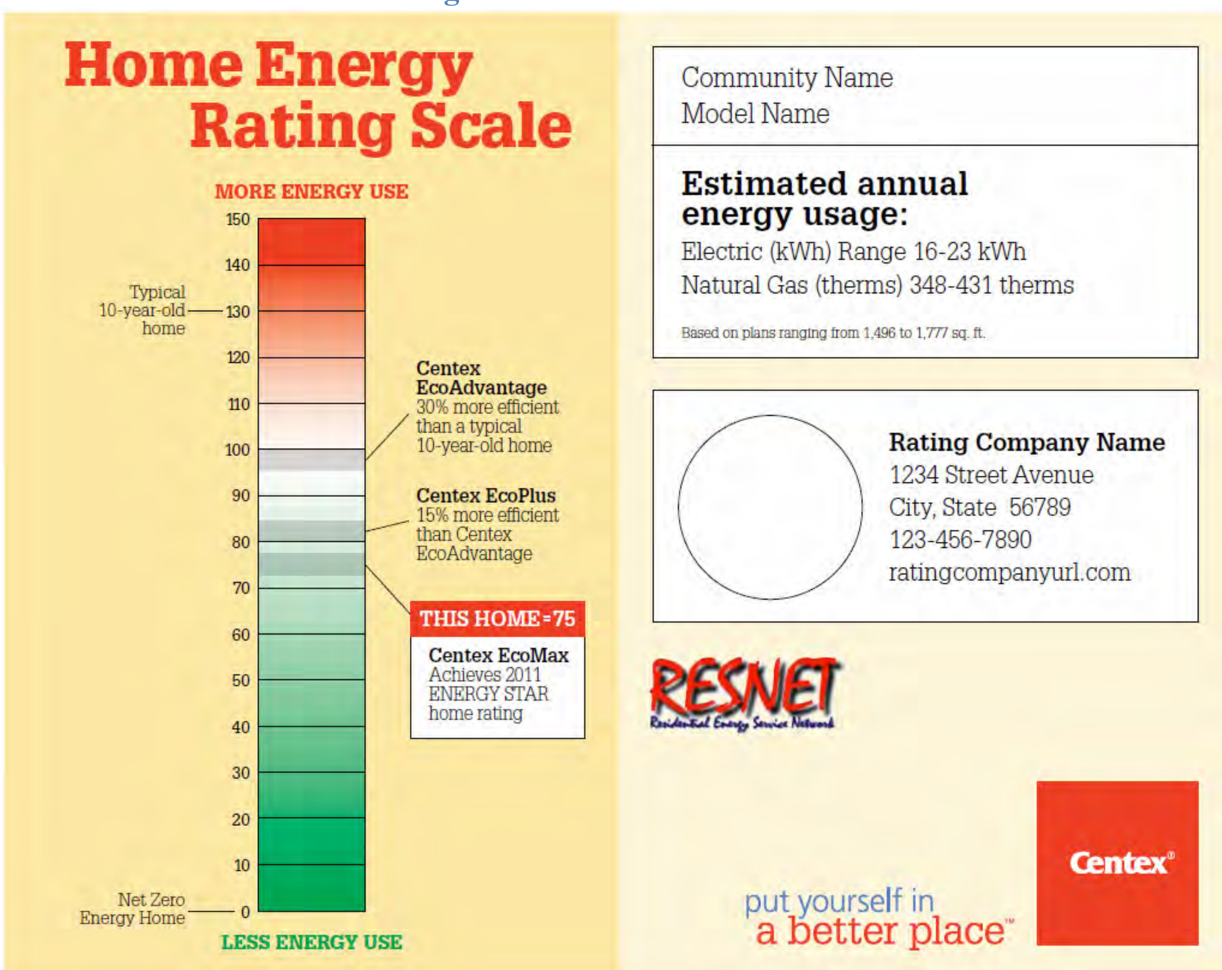


Figure 3: HERS Index Scale[28]



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[28] RESNET, http://www.resnet.us/images/content/yardstick_large.jpg, Accessed 12/30/11

Figure 4: Example HERS Label

For new home construction, the rating is generated by simulating the proposed design with RESNET certified software and then verifying that the planned efficiency measures (and the effectiveness of their installation) are as the plan specifies (or else the input is adjusted and the model is rerun). For an existing home, conditions are observed and measured according to RESNET standards by a RESNET certified rater and then simulated using the same qualified software. The resulting energy use is compared to that simulated for the "reference building," a home of the same size and the same number of stories that complies minimally with the code. Typical aspects of the home that will be inspected, first from plans for a new home, and then verified in the field, include the areas and orientations of walls and windows, the conditioned floor area of each of the stories of the home, the measured leakage of the ducts at a reference pressurization level, the measured leakage of the whole home at a specified pressurization level, the insulation levels of all insulated areas, a subjective, but repeatable estimate of the quality of insulation installation, the U-values and solar heat gain coefficients of windows, the efficiency of heating and cooling equipment, etc. Since the rating encompasses the entire energy consumption of the home, the audit will look at the efficiency of built-in lighting systems as well as the efficiency of appliances to the extent that they are found in the home.

The energy inspection data set is entered into a RESNET-certified software program. At present there are four such accredited software programs: OptiMiser, EnergyGuage, EnergyInsights, and REM/Rate.[29]. The RESNET standard includes requirements for certification of software. These begin with requirements concerning the accuracy of the software simulation engine, but devote most of the effort to describing what assumptions must be made in doing the simulation. These assumptions apply both to the operation of the building being rated as well as to the operation of the reference building which it is compared to. They include such parameters as thermostat set point, how to treat proposed design with very large fenestration areas, how to determine a reference building heated by electric resistance, etc.

RESNET includes quality control/quality assurance (QC/QA) standards. The method for achieving QA/QC standards is that RESNET will certify "providers" who in turn supervise raters. A provider must oversee the quality of ratings, assuring that the RESNET standard of re-inspection by an independent rater of at least 1 percent of all ratings, but at least one (done in the previous year by a given rater), is met. The re-inspection/re-rating must agree with the original rating within 3 points in the HERS scale (typically within 3 percent). Procedures are specified for what to do if the test is failed. RESNET in turn supervises the QA/QC of the providers. The system includes a knowledge base that the raters must be able to master, as determined by the administration of a test. The test includes both written and field work. It also includes standards for training and certification of training providers.

As of 2010, RESNET had 4,000 raters nationwide.[30] The size of this network is determined primarily by market demand: when the demand for ratings rises in a particular area, as it did in Texas when the state promoted energy efficient homes as a means of meeting its Clean Air Act requirements for pollution reduction and thus encouraged rapid market acceptance of ENERGY STAR homes. The RESNET standard is maintained using procedures similar to those of ANSI, the U.S. member agency of the ISO. RESNET became an ANSI accredited standard developing organization in January 2012 and its technical standards will be subject to a full ANSI certification process in the immediate future.

[29] RESNET, National Registry of Accredited Ratings Software Programs, http://www.resnet.us/programs/energy_rating_software, Accessed 5/24/12
[30] RESNET, 2010 RESNET Annual Report, http://www.resnet.us/about/Annual_Report_2010.pdf, Accessed 5/24/12

26 of the top 100 home builders have signed MOUs with RESNET to rate all of their homes and a total of 120,000 homes were rated in each 2010 and 2011. Up until recently, RESNET did not have a required format for what the label should look like, and as builders began to display HERS ratings labels, each builder chose their own display format. More recently, RESNET has decided to create a uniform standard label that will include both the HERS score on a numerical basis and on a graphic scale basis as well as the projected energy use (measured in cost units) of the home.

California Energy Commission HERS II Rating. As discussed, the RESNET HERS system is an asset rating. California has promulgated its own HERS rating system that relies on the RESNET HERS system. California's system was originally directed in 1999 for the purpose of verifying compliance with California's Title 24 Building Energy Efficiency Standards.[31] In 2008, the California Energy Commission (CEC) promulgated phase II of its HERS system, known as CEC HERS II. The HERS II report includes a rating on the California HERS Index (see Figure 5 below), as well as estimated energy use based on simulated consumption, energy bill data normalized to weather data used in the simulation model, and raw energy bill data for a 12-month period . For the estimated energy use, the HERS II rating allows the rater to take a custom approach to better match the estimated use number to bill data by simulating energy uses that are not included within the HERS rating or conditions that are different than those of the rating. Examples of the former includes swimming pools, hot tubs, or elaborate home offices, or other commercial activities, while examples of the latter include families that heat their homes to 80°F during the winter while leaving windows open or alternately who only turn on the heat if the interior temperature drops below 60°F. These "as- operated" simulated energy use information should be comparable to the meter readings; and if they are not, these can lead to insights about either errors made into the inputs to the asset rating or insight into operational problems that the home is having.[32]

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[31] Note that, unlike most other states, California develops its own energy codes rather than adopting the model codes developed by the ICC and ASHRAE.

[32] California Energy Commission, Home Energy Rating System Technical Manual, http://www.energy.ca.gov/2008publications/CEC-400-2008-012/CEC-400-2008-012-CMF.PDF, Accessed 5/24/12

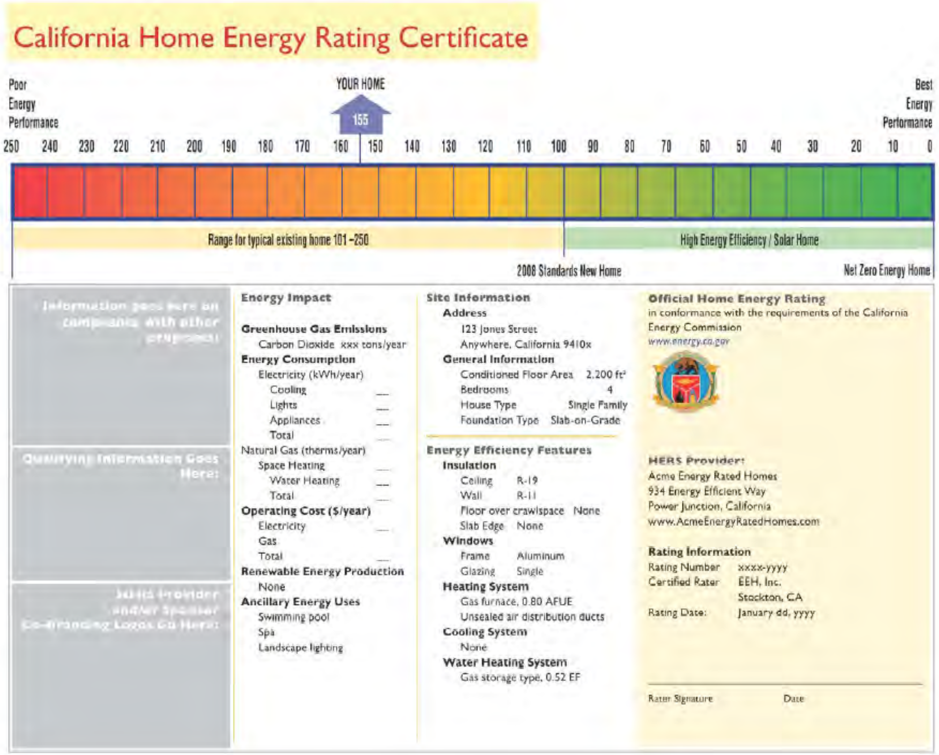

Figure 5: Sample California Home Energy Rating Certificate ENERGY STAR for New Homes

The Environmental Protection Agency's (EPA) ENERGY STAR program includes an ENERGY STAR designation for new homes, which is a normative label that distinguishes new homes that meet certain efficiency standards (see Figure 6 for an example of the label). The designation is available for single family homes, multifamily buildings of 3 stories or less that are permitted as residential and have separate HVAC and hot water systems for each unit, and multifamily buildings of 5 stories or less that sit on top of commercial space as long as the units have separate HVAC and hot water systems. In order to qualify for the ENERGY STAR labels homes must be 15 percent more efficient than the 2004 IECC and meet other prescriptive efficiency requirements, including insuring quality installation. In order to qualify, a builder must be an ENERGY STAR partner and the home (or set of homes) must be verified by a third party certified RESNET Home Energy Rater.

Figure 6: Sample ENERGY STAR Qualified Home Label[33]

The exact guidelines for qualification have been updated periodically and EPA is currently transitioning from the Version 2 eligibility criteria to Version 3 (which applies to all homes permitted as of January 1, 2012 and all homes qualified after July 1, 2012, regardless of permit date). Both versions of the criteria have a prescriptive and performance path. The prescriptive path in Version 2 was called the National Builder Option Package and was a package of prescriptive requirements for the building's HVAC system, hot water heater, thermostat, duct work, envelope, windows, lighting and appliances that a builder had to meet to qualify and was intended to reduce energy use by 15 percent compared to the 2004 IECC. Under the Version 3 criteria, the home is subject to modified prescriptive criteria[34]and must be below a certain size limitation to qualify for the prescriptive path.

The performance path is based on achieving a certain number on the HERS Index plus additional prescriptive requirements. Under Version 2, a home had to achieve a maximum HERS score of 85 in the South or of 80 in the North. In Version 3, the maximum HERS value is on a sliding scale that is adjusted for size – if the home is bigger than the maximum size for a home to use the prescriptive path, it must meet a more stringent HERS target.

For both the prescriptive and performance paths, a home must meet certain prescriptive installation requirements, such as the thermal bypass checklist[35]for Version 2 and checklists on the thermal enclosure system, HVAC installation, and water management system under Version 3.[36]

Whether a builder chooses to follow the prescriptive or performance path, every ENERGY STAR labeled home must be verified by a third-party Home Energy Rater. Verification includes review of plans and field inspections post construction according to RESNET standards, as described above. For builders that have demonstrated ability to comply with the ENERGY STAR specifications (which is determined per RESNET standards), only the plans must be pre-verified and then a random subset of homes are sampled to check compliance. This sampling methodology helps reduce the cost of certifying a home as ENERGY STAR.

1.3 million ENERGY STAR qualified homes have been built to date, with over 90,000 built in 2011. There are currently over 5,000 ENERGY STAR for Homes partners. [37]Figure 7 below shows the market penetration of ENERGY STAR new homes by state in 2010, measured by the number of qualified new homes built compared to the number of privately owned housing units permitted.

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[33] Source: North Carolina Energy Office, http://www.ncplusprogram.org/homeitems/images/eslabel.jpg, Accessed 5/24/12

[34] For more information, see: http://www.energystar.gov/ia/partners/bldrs_lenders_raters/ES_Combined_Path_v65_clean_508.pdf?0d6b-45b3

[35] For more information,see: http://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/Thermal_Bypass_Inspection_Checklist.pdf

[36]For more information,see: http://www.energystar.gov/ia/partners/bldrs_lenders_raters/Bundled_Checklists_v68_2011-09-01_clean_fillable_508.pdf?f20e-0051

[37] EPA ENERGY STAR, New Homes Partner Locator, http://www.energystar.gov/index.cfm?fuseaction=new_homes_partners.locator, Accessed 5/24/12

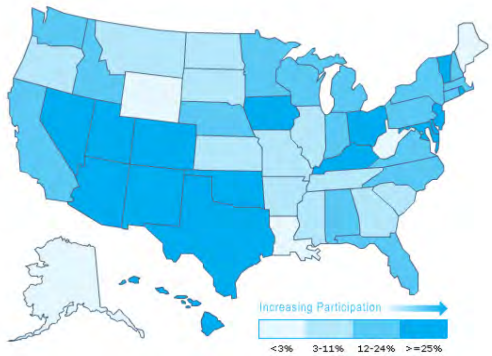

Figure 7: Market Penetration of ENERGY STAR New Homes in 2010 by State[38]

Earth Advantage Institute Energy Performance Score. The Earth Advantage Institute (EAI) Energy Performance Score (EPS) is an asset rating system co-developed by EAI and the Energy Trust of Oregon. Similar to the HERS scale, the EPS is an asset rating based on standardized modeling procedures and operational assumptions. Unlike the HERS Index, the EPS is based on a technical scale that displays both modeled energy use and associated carbon emissions (see Figure 8). For new construction in Oregon, the EPS uses the REM/Rate accredited HERS software which are then turned into the EPS using a proprietary calculator. In other locations, the EPS uses the SIMPLE modeling engine input through the EPS IT Platform. In order to be eligible to provide homeowners with an EPS, an auditor must go through EPS Auditor Certification Training and also be a certified Building Analyst through the Building Performance Institute (BPI). The EPS also includes recommended upgrade measures and a potential after upgrade score. To date, 3500 homes nationwide have received an EPS.[39] It has been used on a voluntary basis in Oregon, a 5,000 home pilot in Seattle, a 1,200 home pilot in Bellingham Washington, and additional pilots in MA, VA, and AL funded through an $11.5 million award from DOE.

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[38]EPA ENERGY STAR, 2010 ENERGY STAR Qualified New Homes Market Indices for States, http://www.energystar.gov/index.cfm?fuseaction=qhmi.showHomesMarketIndex, Accessed 5/24/12
[39]EarthAdvantage Institute, http://www.earthadvantage.org/programs/energy-efficiency/energy-performance-score/program-managers/, Accessed 5/24/12

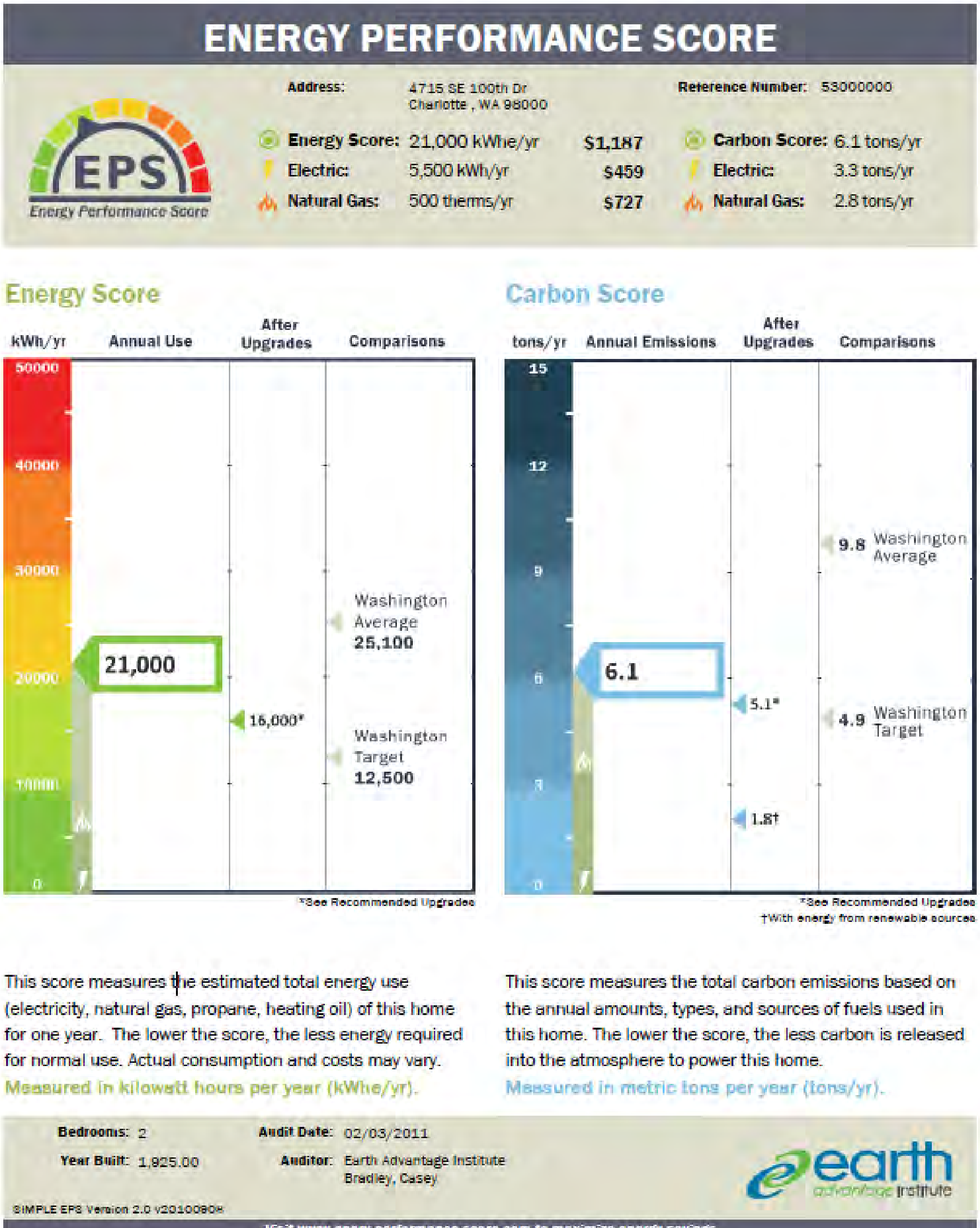

Figure 8: Earth Advantage Institute Energy Performance Score Scorecard[40]

Home Energy Score. In 2010, DOE initiated a program to create another asset rating system for new and existing homes, known as Home Energy Score. The idea behind the creation of Home Energy Score was to create a rating that was cheaper and easier to use than other existing systems so that it would be more widely deployed and encourage retrofits.[41] The concern with this approach is that simplicity and low cost

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[40] Source: EarthAdvantage Institute, http://www.earthadvantage.org/assets/uploads/EPS_Scorecard1.pdf, Accessed 5/24/12

[41] There is little data that we are aware of to date that home energy audits and ratings on their own drive retrofits.

would be traded for accuracy of the score. DOE is currently in the process of finalizing the Home Energy Score Tool for national launch after running a pilot program in 2011.

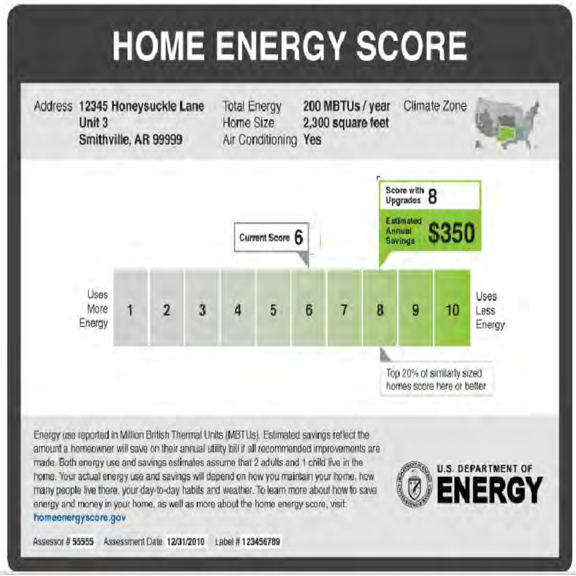

Figure 9: First page of the Home Energy Score report[42]

The Home Energy Score is based on approximately 40 pieces of collected data about the home, including year built, conditioned square footage, number of bedrooms, orientation, insulation levels in walls, foundation, and attic, exterior finishes and construction (walls and roof), attic type, window area and efficiency, HVAC and hot water system year of installation and efficiency, and envelope and duct leakage (measured or estimated).[43] The score is on a one to ten integer bin scale – ten being most efficient – developed using on Residential Energy Consumption Survey (RECS) data. The amount of allowable energy use to obtain a given score varies by climate zone and is shown in Figure 10. In addition to the numerical score, the HES report also shows the estimated total annual energy use in MBTU, recommended improvement measures, and potential score increase and dollar savings with these improvements.

[42] Source: Department of Energy, http://www1.eere.energy.gov/buildings/homeenergyscore/, Accessed 5/24/12
[43] See: http://apps1.eere.energy.gov/buildings/publications/pdfs/homescore/data_collection_sheet.pdf

Note: Energy usage is expressed in million British thermal units (Mbtu)

Climate Zone	Approximate Region*	Score 10 Up to	9 Up to	8 Up to	7 Up to	6 Up to	5 Up to	4 Up to	3 Up to	2 Up to	1 Greater than
1	New England	132	168	204	240	276	312	348	384	420	420
2	NY/PA/NJ	120	155	190	225	260	295	330	365	400	400
3	Great Lakes/MW	130	165	200	235	270	305	340	375	410	410
5	Upper MW	119	156	193	230	267	304	341	378	415	415
6	MW/Plains	116	144	172	200	228	256	284	312	340	340
7	Mid-Atlantic	116	144	172	200	228	256	284	312	340	340
8	Southeast	108	137	166	195	224	253	282	311	340	340
9	Southern FL	112	128	144	160	176	192	208	224	240	240
10	KY	116	144	172	200	228	256	284	312	340	340
11	South	116	144	172	200	228	256	284	312	340	340
12	TX+Plains	116	144	172	200	228	256	284	312	340	340
13	Southern TX	120	145	170	195	220	245	270	295	320	320
14	Rockies	127	163	199	235	271	307	343	379	415	415
15	Desert	102	133	164	195	226	257	288	319	350	350
16	Southwest	108	132	156	180	204	228	252	276	300	300
17	Southwest	116	144	172	200	228	256	284	312	340	340
18	Northwest	102	133	164	195	226	257	288	319	350	350
19	California	88	107	126	145	164	183	202	221	240	240
20	Southern CA	88	107	126	145	164	183	202	221	240	240

* These regional titles are provided to give a general idea of how the U.S. is divided into climate zones. Given climatic variations within individual states, the zones do not correspond precisely with commonly understood geographic regions, such as Southwest, Northeast.

Figure 10: Home Energy Score Bins[44]

The scoring tool used to generate the Home Energy Score is within LBNL's Home Energy Saver Suite and runs on the DOE-2 engine.[45] An auditor must be BPI or RESNET accredited and go through a Home Energy Score training to be eligible to use the tool. The tool offers a user friendly interface, which enables the auditor to input the data points mentioned above, but not to adjust the set assumptions, one screenshot of which is shown in Figure 11.

Figure 11: Home Energy Scoring Tool User Interface[46]

[44] DOE, Home Energy Score – Energy Usage and Points, http://apps1.eere.energy.gov/buildings/publications/pdfs/homescore/score_usage.pdf, Accessed 5/24/12

[45] For more information see: https://sites.google.com/a/lbl.gov/hes-public/home-energy-scoring-tool, Accessed 5/24/12

[46] Source: DOE Home Energy Score

In 2011, DOE ran a pilot program to test its Home Energy Scoring Tool in the states of PA, MA, IL, VA, IN, OR, SC, TX, MN, and UT in which over 1000 homes were scored. The purpose of the pilot was to test whether they were collecting the right data, whether the bin distribution was correct, how assessors and home owners reacted to the tool, whether diagnostic tests affected the result of the tool, and the accuracy of recommendations. DOE is currently in the process of refining the analysis tool and recruiting partners for the national launch of the program.

Home Energy Yardstick. The EPA ENERGY STAR program also has developed an operational rating tool for homes called Home Energy Yardstick. Home Energy Yardstick is a simple online tool which allows anyone to input 12 months of utility bills (monthly or annually), home location, number of residents and square footage and produces a numerical score from zero to ten (see Figure 12 below). Home Energy Yardstick is a useful tool for homeowners interested in learning more about their home's energy efficiency and how much energy they use, but is not a sophisticated enough tool to provide information in a third party (such as a potential tenant, lender, or buyer).

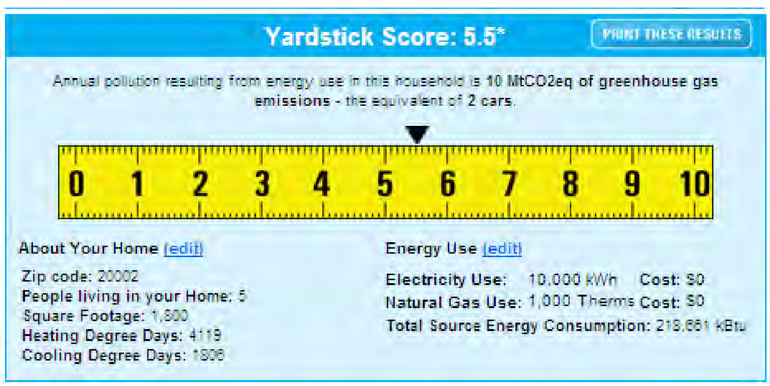

Figure 12: Example Home Energy Yardstick Score

In general, operational ratings for homes can be more problematic. One reason is that operational ratings may disclose behavior of the occupants that violates legal protections of privacy. For example, one major utility found that operational ratings could be a reliable predictor of the incidence of illegal drug manufacture or processing activities in homes. Clearly, as well, high operational ratings could be indicators that the home is being operated with excessive levels of occupancy compared to code or that business uses are taking place on properties in which such uses violate local land use regulations. Operational ratings may be a valuable complement to asset ratings if they are used exclusively by the resident, but could easily become problematic if disclosure of the rating was required by law, or even by custom.

Operational ratings may also vary radically due to family-to-family variations in behavior: even in the 1970s when base energy use was higher than today, a Princeton University research program found 2:1 variations in the energy use of identical adjacent townhouses.

2. Commercial Rating Systems

Background. While there has been significant deployment of asset ratings (in particular the HERS rating) on the residential side in the US, there is not yet a commercial asset rating systems in wide deployment, although several are currently under development. Conversely, the ENERGY STAR Portfolio Manager operational rating is widely used. As noted above, the absence of an asset rating system with the consistency and quality assurance provisions of the HERS system for commercial buildings has been a major stumbling block for the effectiveness of the Section 179D tax incentive for efficient buildings, as well as the incorporation of energy performance data (measured in annual cost) into appraisals. It also raises the cost for participation in the U.S. Green Building Council's (USGBC) LEED program significantly due to the cost of energy simulation (LEED requirements are discussed in Section 4.b.i.).

COMNET Modeling guidance. As in the residential case, asset ratings for commercial buildings would appear to be the most valuable information on building energy use to overcome market failures for most applications. An asset rating will not change as a consequence operational changes to the building which may vary in short term, such as what types of tenants the building attracts and what their operational behaviors are. For example, the fact that the current tenant includes a law firm that drives its people very hard and induces them to work 14-hour days, 6 days a week may not be predictive of its value when that tenant moves out and is replaced by a tenant with more ordinary working conditions.

Over the past decade, particularly as policies and systems such as ENERGY STAR and LEED gained significant market share, and as Section 179D was developed and ASHRAE began to develop policies on labeling buildings for energy use, the many participants in the building efficiency non-profit community in North America have recognized the need for a nationally-consistent asset rating system for commercial buildings. This was evident by the fact that the US had (and still has) a number of different programs that were at risk of trying to do the same thing in different ways, including the ASHRAE system for demonstrating performance-based compliance to ASHRAE 90.1 (and more recently for labeling buildings through ASHRAE BEQ, discussed below), the USGBC's LEED system that assigns points for improvements in energy efficiency beyond code, the ENERGY STAR Target Finder program (see below for description), the Section 179D tax deduction, and numerous utility-sponsored programs that based incentives on percent savings beyond code. Increasingly, percent savings beyond code has become a marketing tool for building owners and developers, so there is a need for uniformity in how this is calculated.

The result was the development of the COMNET system in 2009, named in parallel to RESNET by a group of non-profits led by the New Buildings Institute (NBI) and including RESNET and the Institute for Market Transformation (IMT). The COMNET Modeling Guidelines and Procedures were developed in parallel with the most advanced system for rating buildings that, however, applied only in the state of California, specifically the system used in the "alternative calculations method" (ACM manual) associated with each triennial revision of California's building code. COMNET represents a harmonization of these various approaches, combining the basic structure of ASHRAE 90.1 and Appendix g of that document (which were used for LEED points) with the much more detailed and prescriptive modeling assumptions in the ACM manual. By automating the inputs to the software and in particular automating the development of the reference building, it has been estimated that the COMNET system reduces the cost of an engineer's inputting a simulation model by about two-thirds, while increasing repeatability and accuracy.

The COMNET Commercial Buildings Energy Modeling Guidelines & Procedures[47] is an ANSI-style consensus document; it was developed using ANSI consensus procedures but not by an ANSI-designated Standards Development Organization. COMNET's stakeholders' intend to subject the standard to ANSI procedures in the immediate future. The COMNET Modeling Guidelines & Procedures contain specifications for how to build software that can meet three purposes in a standardized way: 1) eligibility for the section 179D commercial building tax deduction; 2) calculating percent savings from code for green building system points; and 3) estimating energy use during the design phase of a building to be used in an energy label. The modeling guidelines contain detailed information on how to establish the baseline building, operational assumptions (e.g. thermostat settings, occupancy, miscellaneous loads,

[47] COMNET Commercial Buildings Energy Modeling Guidelines and Procedures, http://www.comnet.org/mgp/, Accessed 5/24/12

HVAC schedule, lighting, etc), standardization of how to calculate percent savings (which can vary depending on whether the baseline includes total energy use or just regulated energy), requirements for software modeling engines, standardized report formats, acceptable modeling input ranges, and energy cost data.

At the time of writing, there is not any COMNET-compliant software available, so the system cannot, in practice, be used. However, more than one software company has indicated that it plans to seek COMNET accreditation for its software by early 2012.

The COMNET standard was developed with a global perspective in mind, since it appears that there is no national standard anywhere in the world of comparable comprehensiveness and technical quality. As the COMNET standard goes through ANSI's formal procedures, it is the hope of the COMNET team that it will attract global comment in general, and Chinese comment in particular.

Massachusetts Commercial Asset Rating Program. The state of Massachusetts has also identified the need for a commercial building asset rating system and is in the process of developing an asset rating program. In December of 2010, the MA Department of Energy Resources (DOER) in conjunction with the National Governors Association Policy Academy on Building Retrofits developed a white paper outlining its plan for a commercial building asset rating pilot program.[48] DOER received many public comments on the white paper supporting the need for an asset rating system and also the need for inexpensive energy assessments. At the time of the white paper, DOER planned to create an asset rating label that would use a technical scale, including metrics for site energy use intensity and a complementary greenhouse gas metric that would be developed using standardized modeling inputs, such as those outlined in the COMNET Modeling Guidelines and Procedures. The asset rating would be generated using data collected during an onsite assessment of the building, similar to an ASHRAE Level II audit. The program would also include quality assurance procedures to insure accuracy and repeatability.
In December, 2011, the nonprofit regional efficiency group Northeast Energy Efficiency Partnerships (NEEP) issued a request for proposals (RFP) in conjunction with MA DOER on innovative methodologies for assessing and calculating a commercial building's as built energy efficiency. As of the time of writing, the RFP was still accepting responses. NEEP and DOER plan to select several methods as a result of the RFP to test in the first phase of the pilot on 12 commercial office buildings in the Boston area in the winter and spring of 2012. In phase one of the pilot, DOER and NEEP will compare the innovative assessment methods to standard in depth methods to assess accuracy, repeatability and ability to predict energy use. From the first phase of the pilot, they plan to select the most promising methodology or –gies that they will than test in the fall of 2012 on a larger set of commercial office buildings in eastern Massachusetts.[49]

DOE Commercial Asset Rating Pilot. DOE recently issued a request for information on its plan to develop an asset rating program. While the DOE program is still in its early stages and many decisions about the specific aspects of the program are still being made, the current plan is for the program to consist of an asset rating system that will convey a commercial building's as built energy performance and an free online asset rating tool that will allow owners and operators to assess their building's efficiency, recommend efficiency measures, and produce an asset rating. DOE is considering have such a

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[48] Massachusetts Department of Energy Resources, An MPG Rating for Commercial Buildings: Establishing a Building Energy Asset Labeling Program in Massachusetts, http://www.mass.gov/eea/docs/doer/energy-efficiency/asset-rating-white-paper.pdf, Accessed 5/24/12
[49] Northeast Energy Efficiency Partnerships (NEEP), Request for Proposals, http://neep.org/uploads/NEEPResources/id816/RaisingBAR_RFP_Appendix_Dec8_2011.pdf, Accessed 5/24/12

tool be tiered so that both building owners and operators could use it with limited information to produce initial assessments and recommendations and qualified professionals could also use it to produce verified rating. DOE is currently developing plans for its pilot which it plans to launch in Spring 2012. Given the simultaneous work of COMNET, the State of Massachusetts and ASHRAE on asset ratings, it is NRDC's view that it is important for DOE to work in coordination and harmoniously with these other systems, rather than going in a different direction.[50]

ENERGY STAR Target Finder.EPA's ENERGY STAR has a rating system for the design of new buildings called "Target Finder," which is related to the ENERGY STAR Portfolio Manager tool (described below), but for new construction.[51] Target Finder is not, however, a procedure for generating an asset rating or a prediction of energy use given a set of design parameters for the building. Instead, it is a tool that allows the user to determine whether a building would qualify for the ENERGY STAR rating based on designed energy consumption, which is achieved for existing buildings through Portfolio Manager based on energy bill data. As described in more detail below, the ENERGY STAR rating designates a building that has an energy use intensity in the top 25th percentile compared to a statistically derived data base of comparable buildings in a given climate. Target Finder allows the Architect of Record to submit the designed energy use intensity and if it meets the statistical target, the buildings can receive the "Designed to Earn the ENERGY STAR" designation. However, there is no guidance whatsoever provided in the program on how to do the energy simulation and what relation that simulation has to an asset rating or a custom prediction of the energy use of the building, although the context would suggest that the latter is the intended goal. As stated by ENERGY STAR, "any calculational process that yields these [energy consumption estimates] is acceptable".[52]

This is not a significant problem for the program, since the actual ENERGY STAR label described below is only awarded after operational data has been collected. A building will only receive the ENERGY STAR label unless its metered energy use meets the program's target regardless of the accuracy of the simulation.

COMNET is intended to fill in this void by allowing a simpler and more repeatable prediction of metered results in the context of the simulation aspect of Target Finder.

ENERGY STAR Multifamily High Rise. The EPA ENERGY STAR program also contains a designation for high rise multifamily buildings that are designed to be 15 percent more efficient than ASHRAE 90.1-2007. Similar to Target Finder, the ENERGY STAR high rise multifamily program does not provide standardized modeling assumption or procedures. In order to qualify for the ENERGY STAR, a developer of a multifamily building must partner with ENERGY STAR, submit an application, submit a proposed building design verified by a licensed professional (Professional Engineer or Registered Architect), submit an As-Built Submittal to verify that the building is built as designed, and monitor the energy performance of the building for at least two years following issuance of a Certificate of Occupancy.[53]

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[50] Department of Energy, Commercial Building Energy Asset Rating Program, http://www1.eere.energy.gov/buildings/commercial_initiative/assetrating.html, Accessed 5/24/12

[51] For more information, see: http://www.energystar.gov/ia/business/tools_resources/new_bldg_design/presentation08/es_challenge_presentation.html Accessed 5/24/12

[52] EPA ENERGY STAR, http://energystar.supportportal.com/link/portal/23002/23018/Article/16909/How-do-I-obtain-the-final-energy-numbers-for-Section-4-in-Target-Finder Accessed 5/24/12

[53] EPA ENERGY STAR, ENERGY STAR Qualified Multifamily High Rise Buildings, http://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.nh_multifamily_highrise Accessed 5/24/12

ENERGY STAR Portfolio Manager. The ENERGY STAR Portfolio Manager system, in contrast, is an operational rating. It is based on metered energy consumption over the course of at least a year, modified by statistically-determined adjustments based on weather variations, building type, size, occupancy type, etc. The privacy concerns that make residential operational ratings problematic for single-family residences are much less important for commercial buildings, and several municipalities have developed disclosure ordinances based on the existing ENERGY STAR ranking system. The Portfolio Manager system has been widely used and is well known by many building owners and operators. As of mid-year 2011, almost 230,000 buildings had been benchmarked using Portfolio Manager.[54]

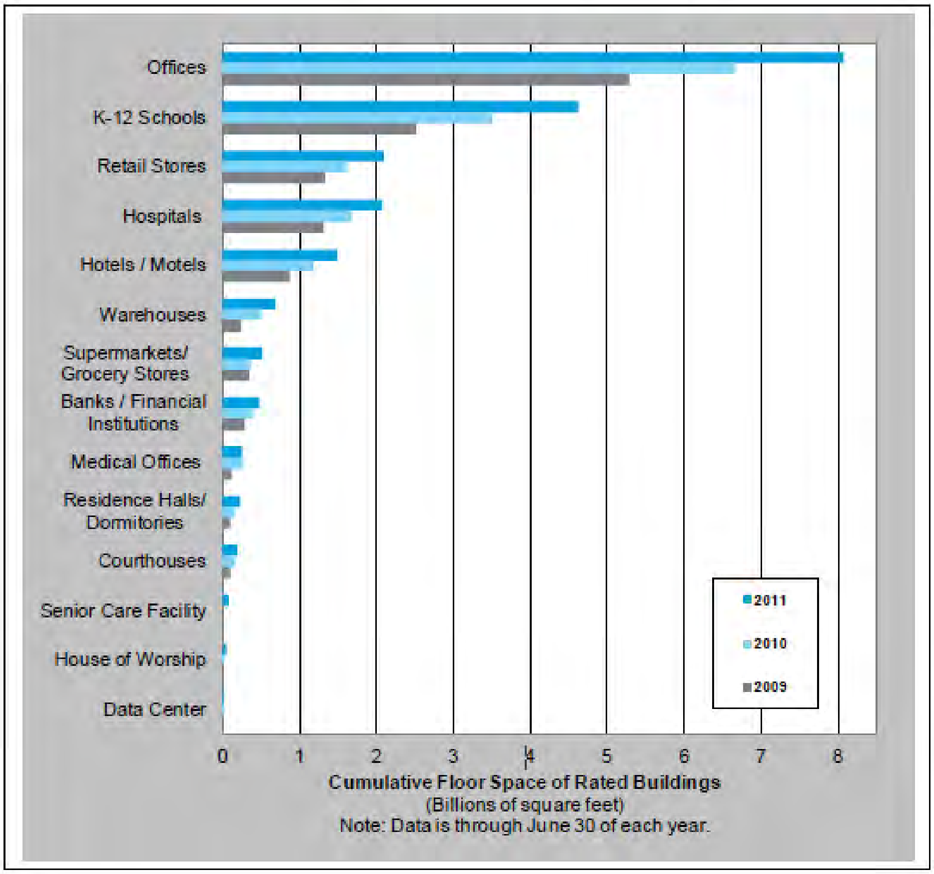

Figure 13: Cumulative Floor Space Scored as of 2010 Using Portfolio Manager, by Building Type[55]

Any building can enter energy and water usage into Portfolio Manager and track weather normalized source energy use intensity, but the ENERGY STAR rating is only available for specific building types: banks and financial institution, courthouse, data centers, hospitals, hotels, houses of worship, schools, medical offices, municipal wastewater treatment plants, offices, residences halls/dormitories, retail stores, senior care facilities, supermarkets, and warehouses. The ENERGY STAR rating designates a building that performs in the top 25th percentile in a given year compared to comparable buildings in the

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[54] EPA, ENERGY STAR Snapshot: Measuring Progress in the Commercial and Industrial Sectors, Fall 2011, http://www.energystar.gov/ia/business/downloads/ENERGY_STAR_Snapshot_Fall_2011.pdf?83b7-529b, Accessed 5/24/12

[55] Source: Ibid

Commercial Building Energy Consumption Survey (CBECS) database.[56] CBECS surveys a statistically valid sample of 6000 buildings, including actual billing data plus key operational characteristics (such as use, hours of operation, square footage). In order to determine the rating scale, EPA performs a regression analysis on this data to determine a formula for the dependent variable (energy use) based on a series of independent variables for each building type to find the best fit. The buildings in the CBECS database are then run through this regression and a distribution is made of the ratios of actual energy use to predicted energy use using the equation.[57]

Figure 14 shows an example of the ENERGY STAR rating displayed in a building. The ENERGY STAR rating always denotes the year which is the data-year used to qualify. The building types eligible for the ENERGY STAR score are those for which CBECS has statistically valid dataset for a representative number of climate zones.

In order to qualify for the ENERGY STAR label, Statement of Energy Performance must be generated using the tool and validated by a Professional Engineer. Any person can also use the ENERGY STAR Portfolio Manager tool to track performance in a building or portfolio of buildings over many years, but cannot be eligible for the ENERGY STAR label unless the meet the target requirement and have the validation of a PE.[58]

Figure 14: ENERGY STAR Operational Label[59]

ASHRAE Building EQ. The ASHRAE Building Energy Quotient (bEQ) is another recently developed rating system, which was piloted in 2009 and 2010 and was recently launched. The ASHRAE bEQ system can combine an "as-designed" asset rating with an "in operation" operational rating, as appropriate. The rating is designed for both new and existing buildings. For the "as-designed" rating, a building is modeled in comparison to ASHRAE 90.1 and 189.1. The "in operation" rating must be conducted by an ASHRAE certified energy assessor. As of the time of writing, only the "in operation" rating was available to the general public. The cost of the ASHRAE bEQ rating is $500 to ASHRAE plus

[56] Currently Portfolio Manager uses the 2003 CBECS data. While CBECS nominally is updated every 4 years, the 2007 dataset was statistically invalid and so the Energy Information Administration is just now in the process of collecting the next useable dataset.
[57]EPA, ENERGY STAR Performance Ratings Technical Methodology, March 2011
[58]https://www.energystar.gov/istar/pmpam/help/Portfolio%20Manager%20Tour/Portfolio_Manager_Tour.htm
[59]http://www.energystar.gov/index.cfm?c=business.bus_bldgs

the cost of assessment and modeling.[60]The label for ASHRAE bEQ uses a letter grade scale and is displayed in Figure 15 below.

Figure 15: ASHRAE Building EQ Label[61]

Sustainability and Green Building Rating Systems

LEED

The Leadership in Energy and Environmental Design (LEED) rating system was first developed by the US Green Building Council in the 1990's and has since gained widespread acceptance both in the United States and internationally. Unlike the energy rating systems discuss, LEED attempts to capture all aspects of a building's health and sustainability: energy use, indoor air quality, materials, water use, proximity to transportation, etc. There are currently 9 LEED rating systems: New Construction, Existing Buildings Operations and Maintenance, Core and Shell, Commercial Interiors, Schools, Healthcare, Homes and Neighborhood Development. For each of these rating systems point categories and number of points are determined that are relevant to that particular building category. There are five LEED designations: Certified, Bronze, Silver, Gold, and Platinum which are awarded based on the number of points a project receives.

For example, LEED 2009 for new construction is divided into eight sections: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Innovation and Design Process and Regional Priority. The last two areas are process points, awarded for the way the design process is executed and for attention to special priority items. Innovation and Design Process awards points either for approaching problems in new ways either architecturally or procedurally or for greatly exceeding the performance standard in one of the points. Regional priority credits assign bonus points to addressing local environmental problems – such as additional points for water reduction in the arid southwest of the United States.

Within these 8 sections there are a possible 110 points possible, with a minimum of 40 required for basic LEED certification. Each additional 10 points earned garners an additional level of certification, with the Platinum level beginning at 80 points. There is no weighting to the points from different sections, weight is assigned to various criteria by altering the number of points they are worth.

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[60] http://www.buildingeq.com/index.php/what-is-beq

[61] Source: ASHRAE, http://www.buildingeq.com/index.php?option=com_content&view=article&id=93, Accessed 5/24/12

Currently, there are nearly 8,000 LEED certified projects worldwide.[62] As of 2006, one in seven new buildings built in the United States was being built to LEED standards, which usually represents the high end of the building market.[63]

Rating systems that measure a building's energy efficiency are both currently utilized by the LEED system and could help standardize and reduce the cost of LEED compliance in the future. Specifically the ENERGY STAR Portfolio Manager Tool is utilized by the EBOM rating system to identify building to identify operational improvements in buildings. Under the current LEED EBOM system, a building must achieve the ENERGY STAR to qualify. The LEED New Construction rating system rewards energy and atmosphere points based on percent improvement above code, which could be streamlined with COMNET compliant software and/or an asset rating tool for commercial buildings. LEED for Homes utilizes the HERS index for energy and atmosphere points as well.

The LEED standards are updated periodically and are currently undergoing revision for the 2012 edition of the standards. Multiple drafts of the standard are available for public comment, which influences the development of the standard. In order to obtain LEED certification, a project must be registered with USGBC and an application prepared and submitted with detailed documentation of the points being applied for. This application is then reviewed by USGBC and the final certification awarded or denied. USGBC also has a professional accreditation program through which one can become a LEED Accredited Professional (AP). A LEED AP is familiar with and has experience on LEED projects and can help with the application process. Their participation also qualifies the building for an additional point on the LEED rating system.

Current Use of Ratings/Labels (Policies, etc)

United States

Residential

There are several policies that have facilitated the implementation of ratings in the residential system. As discussed previously these have primarily utilized the HERS rating system.
The first example is the Section 45L tax credit for new homes, which provides a $2000 tax credit to the builder of a new home that reduces heating and cooling energy use by 30 percent compared to a home built to the 2004 IECC. This tax credit was first enacted in the Energy Policy Act of 2005, at which time almost no new homes in the US met these efficiency criteria. The credit was first set to run through 2007 and then extended through 2009 and then again through 2011 (and has just expired as of the time of writing). Compliance with the tax credit is third-party verified using the HERS rating procedures.[64] For builders that build a certain number of qualified homes, they can use the RESNET sampling protocol discussed above to reduce the cost of compliance. Due to the ease of verification, the amount of the credit, and the stringency of the criteria (achievable, but stringent), the credit has been an immense success. The incentives for energy efficient new homes require a 50 percent reduction in heating and cooling energy use compared to a reference model code. This code was developed in a way that assures

[62] cite
[63] Check cite: Fedrizzi, Rick. "Greenbuild 2006 Welcome Speech." Greenbuild Expo 2006, US Green Building Council. Colorado Convention Center, Denver, Colorado. Nov. 2006.
Address.

[64] However, a tax credit compliant home need not receive a HERS rating, which estimates total home energy use, including water heating, lighting, and appliance energy use. The tax credit home needs calculate only heating and cooling energy.

that the HERS rating system in the United States and the code compliance methodology are nearly identical; thus, the U.S. government could adopt the HERS labeling and rating system as the compliance methodology. The success of this program was remarkable: before its adoption less than 600 homes had been built to a specification of 50 percent savings, and a large number of these homes didn't in reality quite meet the 50 percent threshold. And in addition the 50 percent savings was relative to a base case of a SEER 10 air conditioner. At the time the incentive passed, the standard was increased to a SEER 13, and this higher standard became the reference home compared to which the 50% reduction is calculated. Despite this very demanding level of performance, compliant new homes represented 0.8 percent of all new homes sold in 2006, 3 percent in 2007, 4.5 percent in 2008, and over 10 percent in 2009. The program achieved its design intent of taking technology that was virtually unknown when the incentive was established and moving it along the market adoption curve to represent a very substantial niche market.

As displayed in Figure 16, the total number of new homes that comply with the credit has increased every year since it was initiated, despite that the total number of new homes built has dropped over this time period.

Year	Number of Homes Verified as Eligible for Tax Credit	% of New Homes Sold Verified for Tax Credit
2006	7,110	0.7%
2007	23,000	3%
2008	22,000	5%
2009	37,000	10%
2010	21,000	7%
2011	32,000	11%

Figure 16: Number and Percent of New Homes Verified for 45L Tax Credit by Year

Another policy that has driven use of the HERS index is through the DOE Builders Challenge, which uses the EnergySmart Home (E-Scale) based on the HERS Index, shown in Figure 17. The E-Scale can be used by builders who commit to the Builders Challenge and who build homes that achieve a 70 or lower on the E-Scale in addition to prescriptive requirements. As of 2012, the target is being reduced to a score of 60 or lower, plus modified additional requirement, including the use of a size adjustment factor for small homes.

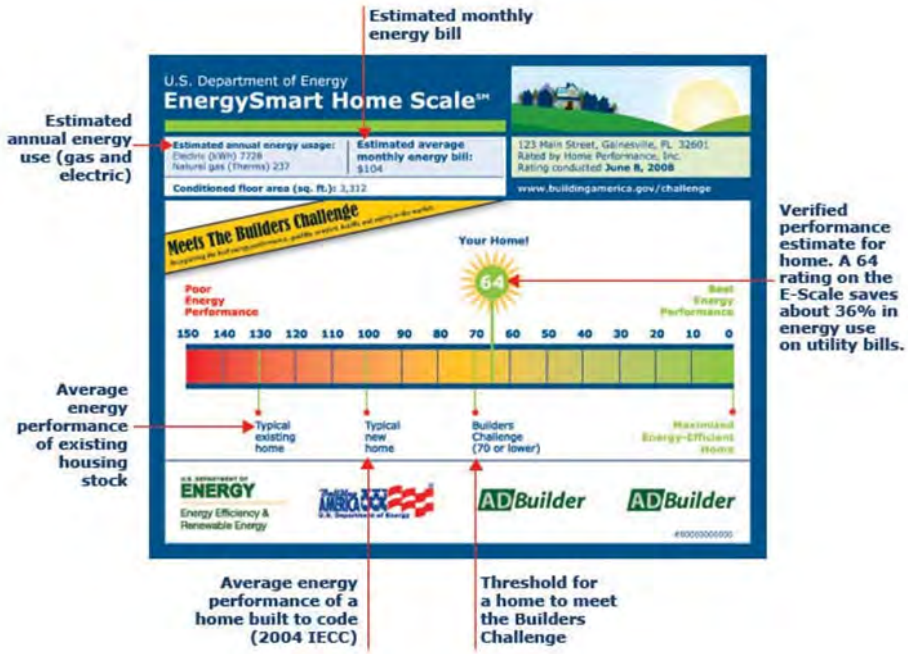

Figure 17:DOE EnergySmart Home Scale[65]

Through the 45L tax credit, the Builders Challenge program, and the ENERGY STAR for new homes program, many home builders have become familiar with the HERS rating system. They have also began to recognize the value of marketing their homes' energy efficiency using energy ratings, which helps them sell homes particularly in today's stagnant market.[66] Consequently, 26 of the top 100 home builders have voluntarily signed Memorandums of Understanding (MOUs) with RESNET to date to rate all of their new homes. Over 92,000 homes were rated in 2010 by builders who had signed MOUs to rate all of their homes. This is a great example of policies driving market penetration and then the market taking it up on its own.

Commercial

Market uptake of Portfolio Manager. As discussed above, the only commercial energy efficiency rating system with significant adoption to date is the ENERGY STAR Portfolio Manager operational rating tool. The most likely reason for the wide adoption of the tool is the ease and low cost of use by owners and managers and the ability to garner increased rents and occupancy rates for buildings that earn the ENERGY STAR, as found in the CoStar study.

Local benchmarking and disclosure requirements. Five cities and two states in the US have adopted local benchmarking and disclosure requirements for commercial and multifamily buildings within the last five years. The size and type of effected buildings as well as who and when the information must be disclosed to, as shown in Figure 18 below. The timing of these requirements also varies by city, but all go into effect within the next five years. These current policies could affect more than 60,000 buildings and

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[65] Source: DOE, http://www1.eere.energy.gov/buildings/challenge/energysmart.html, Accessed 5/24/12

[66] Easley, Claire. Builder Magazine. 2012. "Is HERS Home Building's New Standard?"http://www.builderonline.com/energy-efficiency/is-hers-home-buildings-new-standard.aspx?cid=BP:050412:FULL

an estimated 4.1 billion square feet. Many additional jurisdictions are currently considering adding benchmarking and disclosure policies.[67]

Jurisdiction	Benchmarking (Building Type and Size)		Disclosure					
	Non-residential	Multi-family	On public web site	To local government	To tenants	To transactional counterparties		
						Sale	Lease	Financing
Austin	10k SF+	-	-	✓	-	✓	-	-
California*	1k SF+	-	-	✓	-	✓	✓	✓
District of Columbia	50k SF+	50k SF+	✓	✓	-	-	-	-
New York City	50k SF+	50k SF+	✓	✓	-	-	-	-
San Francisco	10k SF+	-	✓	✓	✓	-	-	-
Seattle	10k SF+	5+ units	-	✓	✓	✓	✓	✓
Washington	10k SF+	-	-	-	-	✓	✓	✓

Table 1: U.S. Rating and Disclosure Policy Summary

*Requirements subject to change by the California Energy Commission

Figure 18: Summary of Benchmarking and Disclosure Requirements[68]

Tax Incentives. While the Section 179D tax incentives for commercial buildings similar is in many ways similar to the section 45L for new homes it has not been widely utilized. The Section 179D deduction was also enacted in the Energy Policy Act of 2005 and rewards buildings that reduce regulated energy use by 50 percent compared to ASHRAE 90.1-2001. While this target is certainly stringent, it is also realistic – yet the incentive is not being claimed on a wide scale. The anecdotal evidence suggests that the costs of modeling to prove compliance with the deduction is more than the amount of the deduction itself and so even if a building does meet these standards, it does not apply for the deduction. This is a case where a streamlined system using COMNET modeling guidelines and procedures could greatly increase the uptake of the credit while facilitating the uptake of COMNET.

Analysis of Existing Technical and Policy Gaps and Barriers

United States

Residential. While there has been much success over the last five years implementing ratings for new homes, there has yet to be sufficient uptake of a rating system for existing homes. There are several potential reasons for this. To start, there has been no policy driver, such as a major retrofit program that encourages home owners to verify the depth of a retrofit to their home with a rating. Although retrofit

[67] For more information, see IMT's comprehensive report: http://www.buildingrating.org/sites/default/files/documents/IMT-Building_Energy_Transparency_Report.pdf

[68] Source: IMT, http://www.buildingrating.org/sites/default/files/documents/IMT-Building_Energy_Transparency_Report.pdf

legislation has been proposed by Congress, no bills have passed and there is currently little appetite for big spending bills. This is coupled with the fact that in general home owners have little knowledge of what makes a home energy efficient, let alone what a home energy rating is.

Another potential driver of ratings for existing buildings that is not being utilized is the assessment of variation in energy costs during the credit worthiness assessment when applying for a mortgage. Finally, while not prohibitive, the cost of a HERS rating for an existing home may prevent home owners from getting a rating, especially when the above described factors are considered.

This record of low market penetration is in contrast to that for new homes, where the fraction of rated homes is approaching 50 percent because: 1) policy drivers, such as ENERGY STAR and Section 45L, that encouraged the rating; 2) there were whole-house utility incentive programs that were based on ratings; 3) the customer for the rating was a homebuilder, who could rate hundreds or thousands of buildings based on one decision; and 4) the cost of ratings is lower, because the rater does not need to rate the building based solely on measurements, and instead can also rely on plans, and also does not have to rate the building twice (before and after improvements).

Even with the success there has been in new homes, there is still additional room for improvements. Targets for tax credit eligible and ENERGY STAR homes should continue to be increased to continue improvements in efficiency. Additionally, while this is already the case in some states, ratings could be further utilized to demonstrate building energy code compliance for new homes.

Commercial

On the commercial side, while Portfolio Manager has been widely utilized and is useful, it is also has flaws and limitations. To begin, it uses the 2003 CBECS database as a reference which is becoming outdated and therefore less meaningful. Furthermore, while Portfolio Manager gives top performers a way to distinguish themselves, it doesn't necessarily drive this performance and it doesn't provide any incentive for further improvements once the top 25th percentile hurdle has been crossed. The latter point can be addressed in part by the implementation of policies that reward based on percentage improvement on the Portfolio Manager scale, rather than solely achieving the ENERGY STAR label. LEED has proposed this type of system for its 2012 revision of the EBOM rating system. NRDC, along with USGBC and the Real Estate Roundtable, have proposed modifications to the existing Section 179D tax deduction that would reward based on improvements along the ENERGY STAR Portfolio Manager scale.

Additionally, access to energy use information can be a major barrier to the wide-scale use of operational ratings for commercial buildings. This issue arises when an owner does not have legal access to information on his tenants' energy use in a large multi-tenant building making it impossible for them to benchmark the building. Conversely, an individual tenant will often not have access to their own utility bill data due to lack of submeters, so they cannot access data on the energy use in their space.

Finally, as discussed above, there is significant need for the development of an asset rating for commercial buildings. Several efforts are underway to develop such a rating and the COMNET Modeling guidance and procedures provide a solid technical basis for the development of modeling tools. A fully developed asset rating could be used for a variety of purposes, as previously discussed, such as code compliance, verification for performance based incentives, etc.

Conclusions and Recommendations

United States

As discussed above, rating and labeling systems that provide information about a building's energy use and environmental attributes are a key policy tool to encourage energy efficient, green buildings. Ratings and labels can provide information to consumers, inform financial transactions, and be used as a compliance mechanism for codes and incentive programs. Several rating systems and corresponding labels exist for both residential and commercial buildings in the US and are in various stages of use and development. There has been significant progress on the development and implementation of these rating and labeling systems over the past few years.

As described above, there are several existing rating systems for single family homes in the United States, which include the RESNET HERS Index, the ENERGY STAR label, Home Energy Yardstick, the Earth Advantage Institute Energy Performance Score, and the DOE Home Energy Score. There has been significant progress on the development and implementation of these systems over the last few years. Specifically, the number of homes receiving HERS ratings has increased significantly, particularly in the new homes space. In each 2010 and 2011, 120,000 homes received ratings, which amounted to roughly 40 percent of new homes sold. Additionally, 26 of the top 100 builders have signed MOUs with RESNET to rate all of their homes. Policies such as the Section 45L tax credit for new homes, the ENERGY STAR label, and the DOE Builders Challenge program have helped encourage and facilitate this market adoption.

In addition to the increased use of the HERS rating system, the EarthAdvantage Institute's Energy Performance Score is now being used throughout the states of OR, WA, MA, VA, and AL with pilots in over 5,200 homes. In 2010, the DOE began to develop a new rating system for homes, Home Energy Score, intended to be cheaper and simpler than the other existing rating systems for home. The system was piloted in 2011 and will be launched in 2012.

For commercial buildings, the only rating system with significant uptake is ENERGY STAR Portfolio Manager, which is an operational rating system that uses a statistical scale based on the 2003 CBECS database. Use of Portfolio Manager has increased steadily since 2001, with increased growth in the past several years. Cumulative total floor space with a Portfolio Manager Score increased almost four fold between 2005 and 2010. This use has been driven primarily by consumer demand, the ease of use of the system, and building owners and managers seeking ways to make their properties more competitive.

In addition to the increased use of Portfolio Manager, there has been significant progress in the developmentof asset rating systems and related tools for commercial buildings over the past few years. Specifically, the COMNET modeling guidelines and procedures have been developed and finalized and software is currently being developed to meet these standards. Additionally several players are working to develop asset rating systems for commercial buildings which are in various stages of development, including the state of Massachusetts, DOE, and ASHRAE (which is working on an asset and an operational rating).

Despite this progress, there is still much work to be done. This includes the need to development, harmonize and update for specific rating systems and put in place policies to increase implementation. We offer the following recommendations with respect to rating systems in the US.

- *Residential:*
    - As described above, certain policy drivers have helped facilitate the increased use of the HERS Index for new single family homes.*The Federal government should continue to encourage and facilitate this use of the HERS Index in new homes through harmony with and as a compliance mechanism for other programs and policies* (e.g., the 45L tax credit, DOE Builder's Challenge, ENERGY STAR etc), with the eventual goal of all new homes receiving a rating.
    - There has been limited uptake of ratings in the existing homes market, where ratings are harder to conduct on a mass scale (as compared to new construction homes where builders can sample) and where there are fewer policies to facilitate the use of ratings. *Policy drivers, such as incentives for performance based retrofits that utilize ratings as a compliance mechanism, integrating home efficiency into mortgage underwriting standards, and building codes that used ratings as a compliance tool, could help drive the utilization of ratings in existing homes*.Energy codes with a performance path should be harmonized with ratings standards: this will simplify compliance and encourage better conformance to codes. American experience repeatedly shows that *ratings by themselves do not lead to retrofit actions, so policies to encourage ratings should be undertaken in the context of other policies that promote retrofits.*
    - *Ratings for existing homes should be harmonized with those for new homes*, because a home is only "new" for the first few months of its 100+ year life, and over 1,000,000 homes rated as "new" are now in the existing homes space. Multiple rating systems that do not produce mutually comparable results lead to potential for consumer and market confusion. Additionally, there is a risk that low cost, less accurate systems will not be as useful in the market place and could lead to consumer dissatisfaction.
    - As more existing homes are retrofit and rated, *data should be gathered to determine whether there are reasonable targets* for savings or absolute levels of efficiency that can be used as voluntary or mandatory targets for retrofits and *policies to encourage retrofits should be adjusted accordingly.*
    - The US should *explore the importance of disclosure of energy rating*s by looking at the effects of doing so in EU member states and in multifamily buildings in US cities that have disclosure laws.

- Commercial:
    - There are several players currently working developing asset ratings for commercial buildings. While it is great to have so much interest in this space, there is also the potential to have the development of conflicting and competing systems. There is a need for *collaboration between the many players working on commercial asset ratings: the resulting systems should work in conjunction with each other, rather than competing.* Otherwise, there is significant potential for confusion in the marketplace. The US government could play an increased role in facilitating this collaboration. Furthermore,rating systems should as much as possible be harmonized globally, as many property owners in the commercial real estate sector have portfolios that span borders and have the need to make comparisons across properties. COMNET is making good progress on this goal in the U.S. but this progress should not be taken for granted.

- As these asset rating systems are developed, it is important that they are developed in such a way so that they *generate ratings that allow for the prediction of actual use in a way that is appropriate to compare with meter readings.* This will facilitate the ultimate goal of integrating asset and operational ratings. This integration allows feedback both on how well a building is being operated and on changes needed to the COMNET methodology that can make the COMNET results more accurately reflect an average of meter readings.
- While the COMNET Modeling Guidelines and Procedures have been finalized, COMNET compliant software needs to be developed and should be designated as a compliance mechanismfor policies, such as Section 179D, ENERGY STAR, LEED, utility programs, and energy codes. This last activity appears to be occurring though ASHRAE but requires monitoring.
- As in the residential space, as more commercial buildings are retrofit and rated, *data should be gathered to determine whether there are reasonable targets* for savings or absolute levels of efficiency that can be used as voluntary or mandatory targets for retrofits and incentive programs should be adjusted accordingly.
- *The Portfolio Manager baseline should be updated.* Currently Portfolio Manager is based on the 2003 CBECS database and there has been significant progress in building efficiency in the US since the collection of this data. Currently, the EIA is starting its survey process for the next edition of the CBECS survey. Congress should continue to fund this effort, which takes several years, and Portfolio Manager should promptly update its baseline when the survey is complete.
- As for residential buildings, *the US should explore the importance of disclosure of energy ratings* by looking at the effects of doing so in EU member states and in US cities that have disclosure laws.

As discussed previously, ratings are a policy tool which helps facilitate the implementation of efficiency in new and existing buildings. The implementation of the above recommendations will both help encourage increased building energy efficiency in both new and existing building, while helping facilitate the further market adoption of ratings in the US.